

# A Felt Experience: Touch Sensors and Cast Objects

Cydnei Mallory & Kimberly Lyle

PLEASE. DO NOT TOUCH THE WORK OF ART  
TOUCH. DO NOT PLEASE THE WORK OF ART  
WORK. DO NOT PLEASE THE ART OF TOUCH  
PLEASE THE ART OF TOUCH. DO NOT WORK  
TOUCH THE ART OF WORK. DO NOT PLEASE  
PLEASE WORK NOT. DO TOUCH OF THE ART  
DO THE ART OF TOUCH PLEASE. WORK NOT  
DO NOT TOUCH THE ART OF WORK. PLEASE  
PLEASE DO WORK. TOUCH NOT OF THE ART















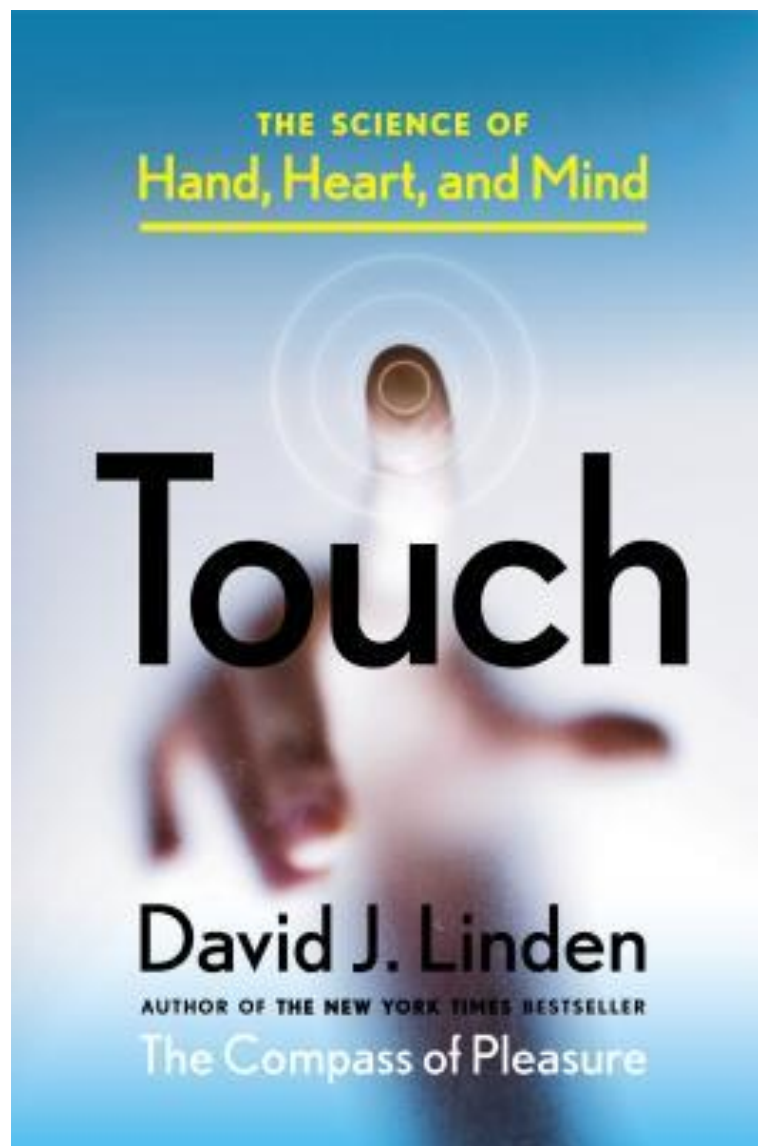




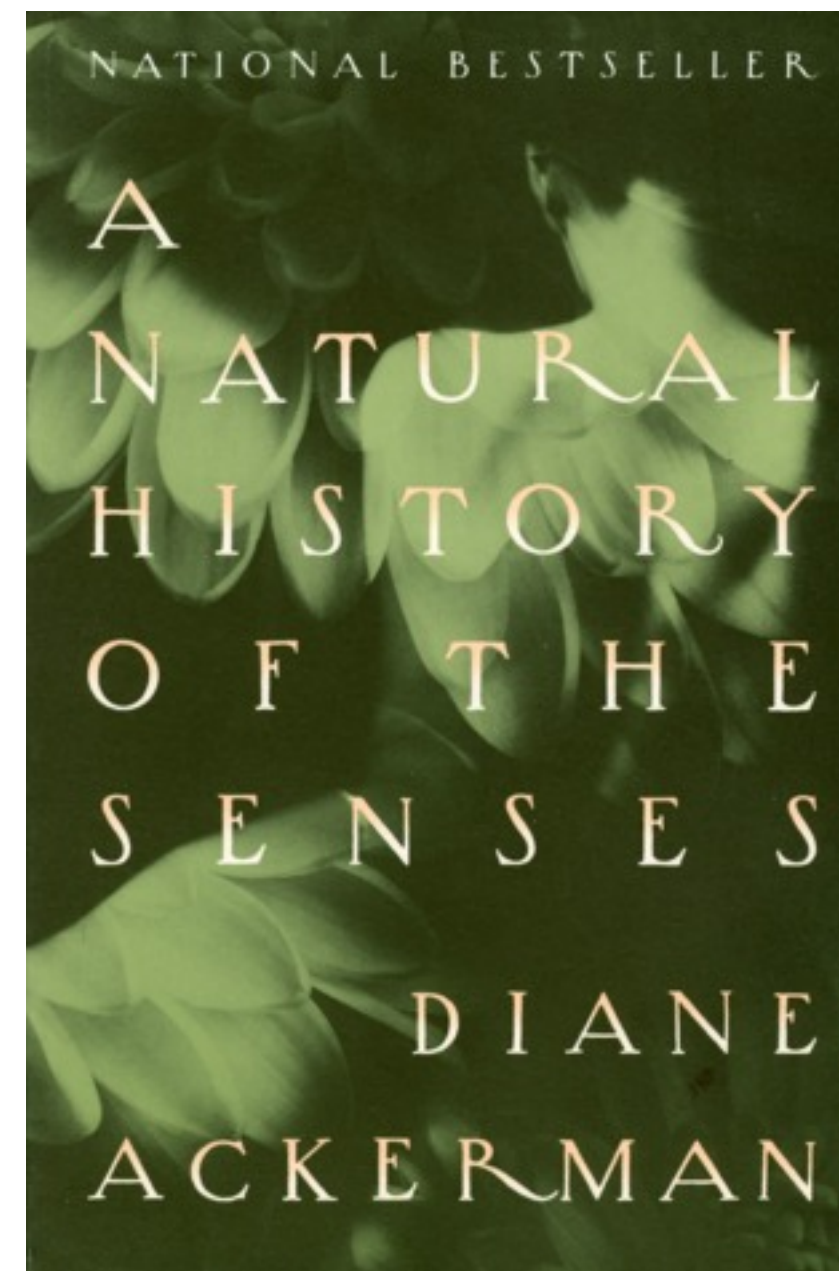


Fig. 9. Close-up of the Mondragone Head with lipstick (photo: author).



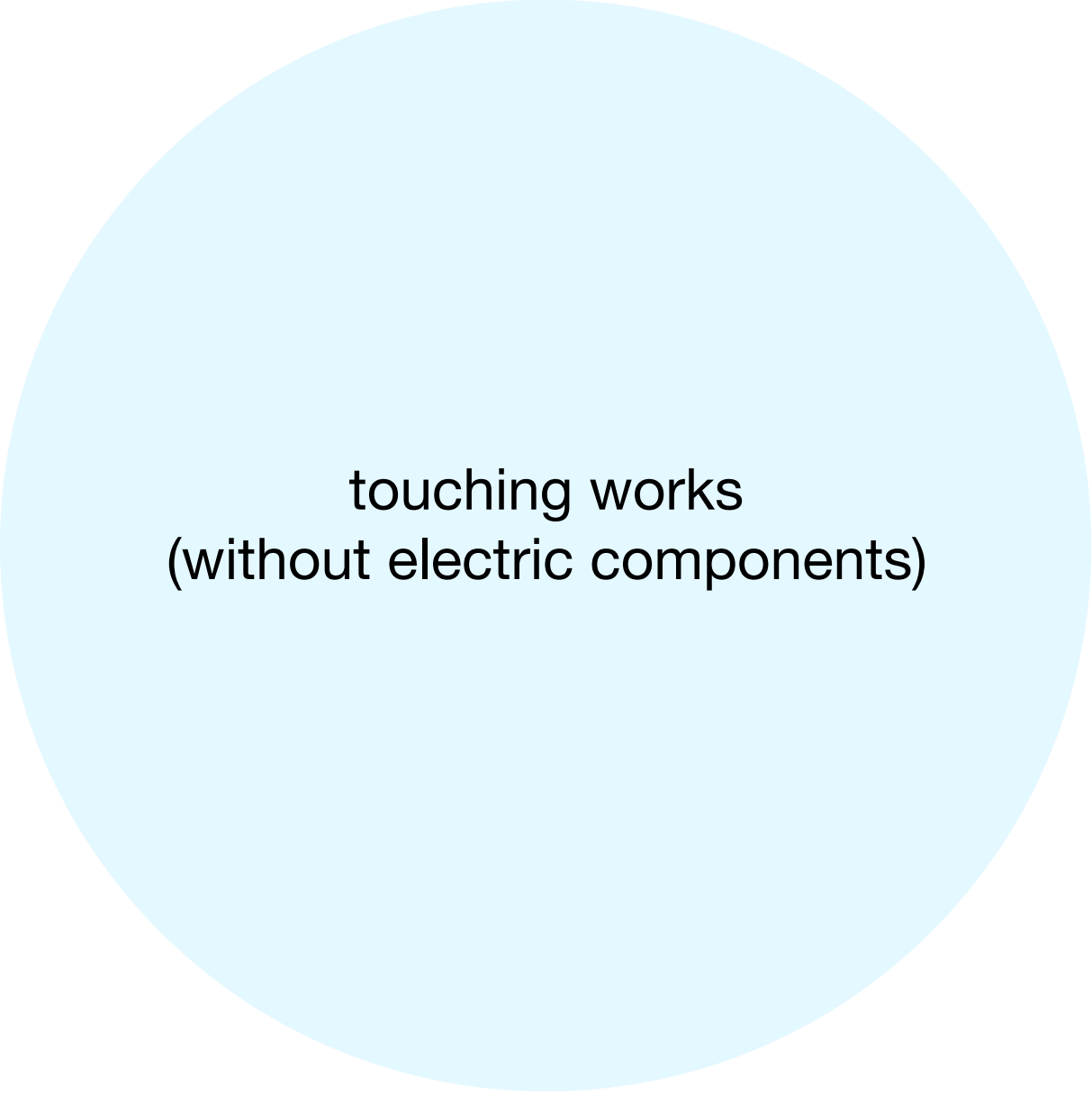


*“Much of our relationships with data and digital information is premised on the notion of information gathering. What happens when we come to know something affectively and corporeally, rather than cognitively or visually?” - David J. Linden*



*“Touch allows us to communicate without the expensive cognitive task of typing or speaking. Our sense of touch is uniquely designed to process information quickly — often without the neural round trip to the brain. Our skin processes subconsciously.” - Diane Ackerman*





touching works  
(without electric components)





Arnolfo di Cambio  
*Statue of St. Peter*  
St. Peter's Basilica, Vatican City  
1300





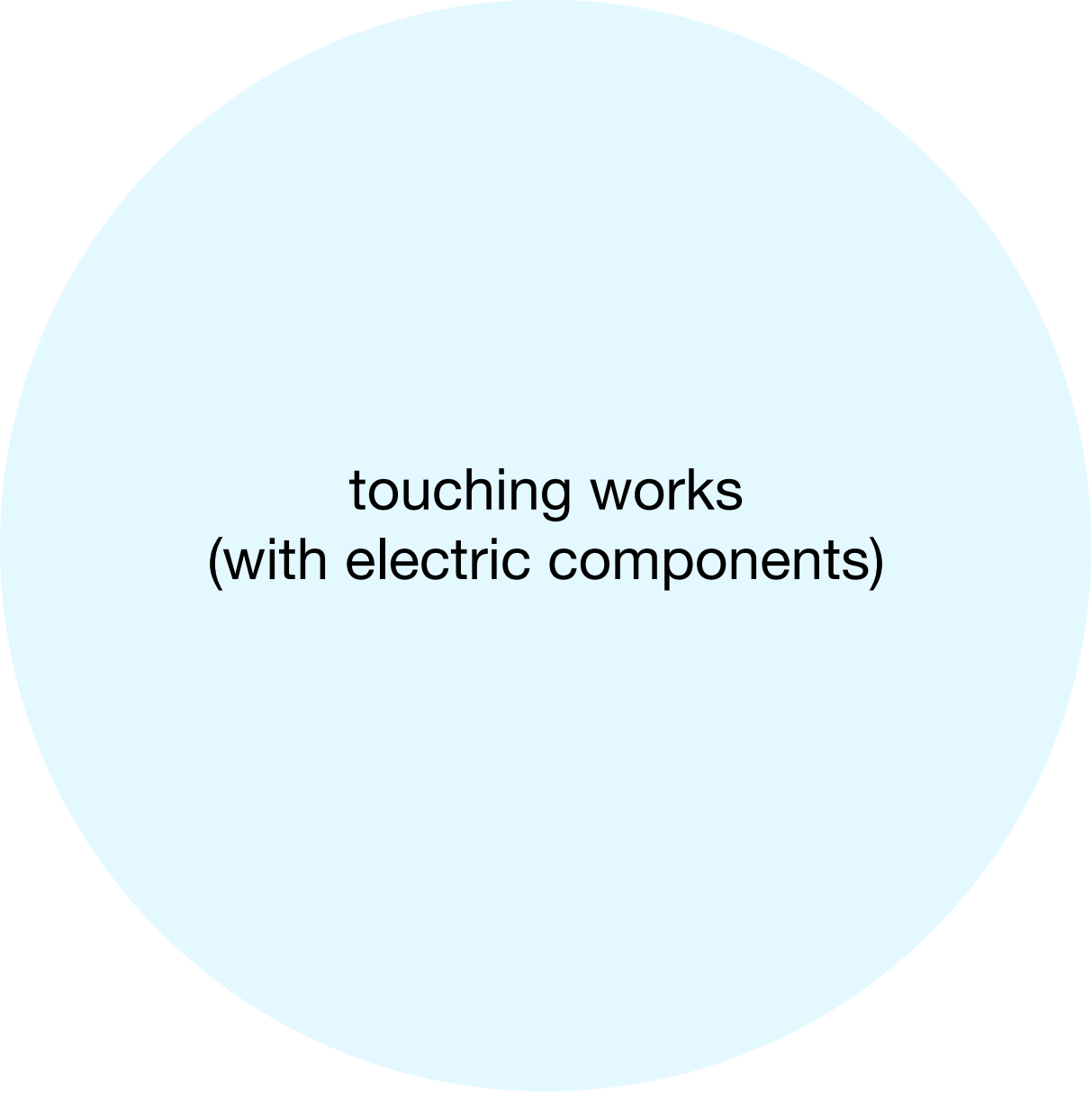
*Juliet*  
Verona, Italy





Tom Otterness  
*Other Worlds*  
Hamad International Airport Playground in Doha, Qatar  
2014





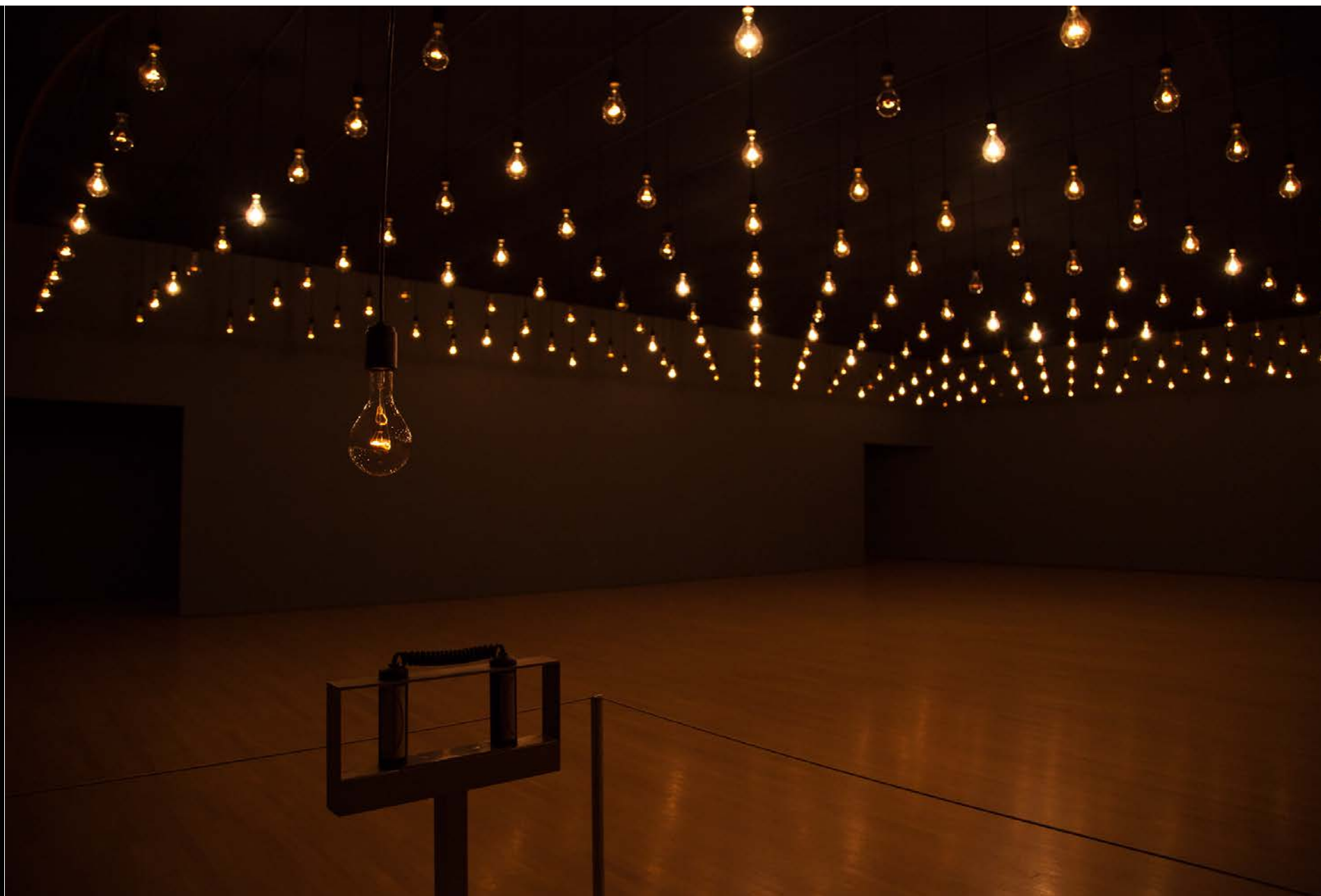
touching works  
(with electric components)





Janet Cardiff  
*To Touch*  
1993





Rafael Lozano-Hemmer  
*Pulse Room*  
Puebla, Mexico  
2006



**"Pulse Room"**

**Rafael Lozano-Hemmer**





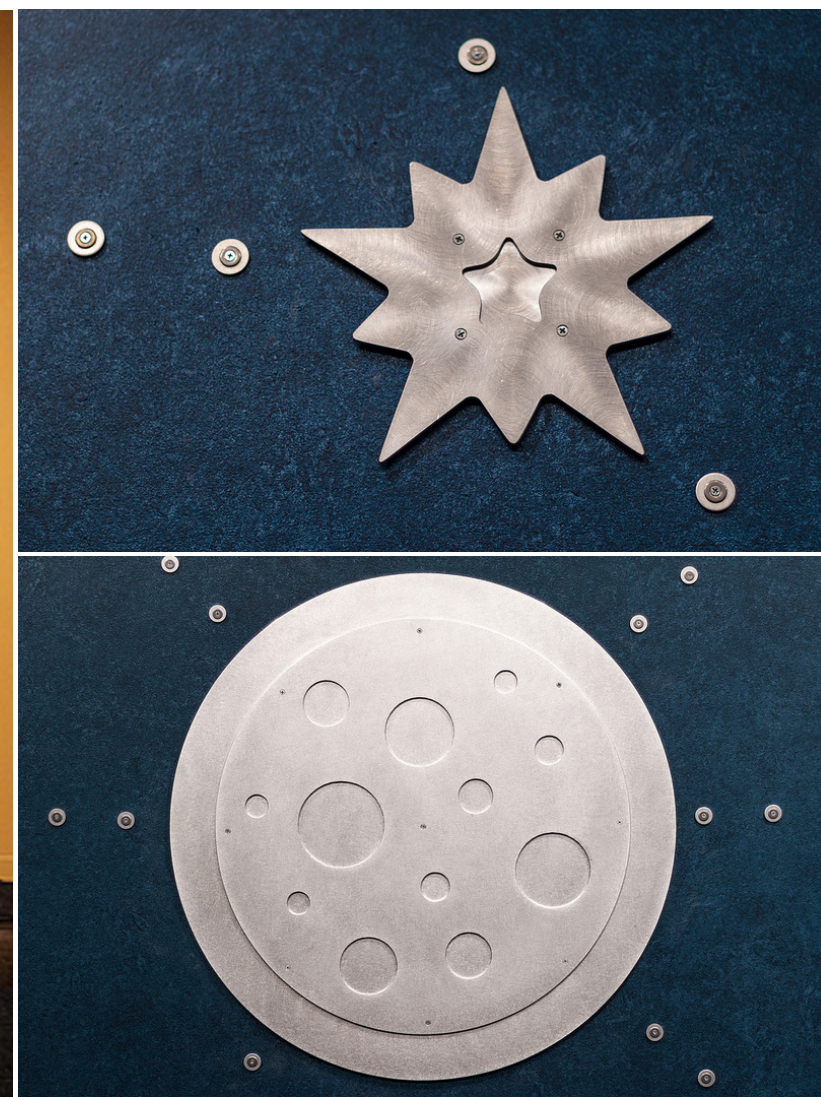


Julianne Swartz  
*We Complete*  
Cambridge Common Park, Cambridge, MA  
2017









Scott Garner  
*Reach*  
Children's Museum of Pittsburgh  
2013









Erwin Stache  
*73.8 Kilo Ohm*  
Düsseldorf, Germany  
2003









Camille Utterback  
*Aurora Organ*  
St. Louis, MN  
2009









Matthew Mosher and David Tinapple  
*weTouch (Interactive Telecommunications)*  
Arizona State University  
2010





Kimberly Lyle  
*Floating Vowels*  
Arizona State University  
2017-18









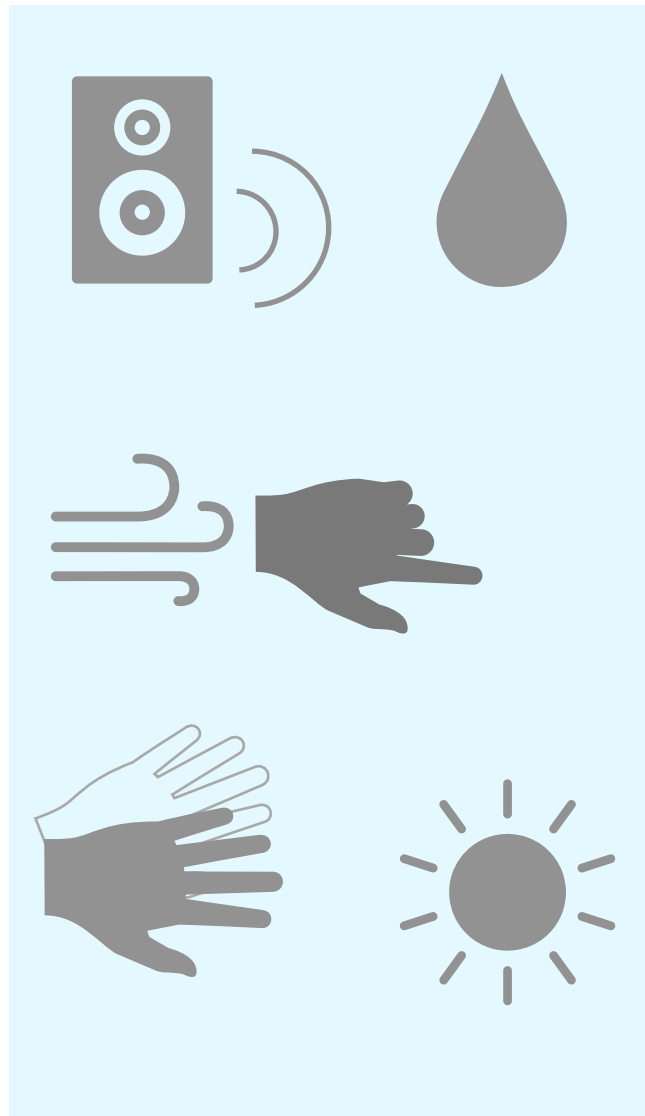
basics of creating an interactive system



# how do sensors work within an interactive system?

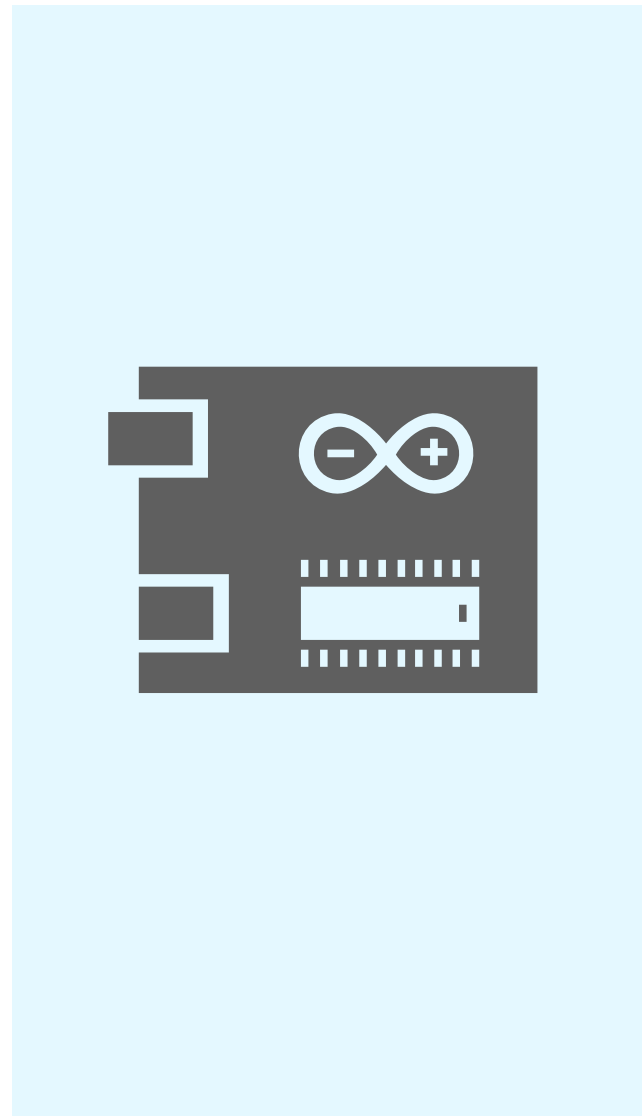
## sensor

anything that detects a change in the environment, they are hidden everywhere around us



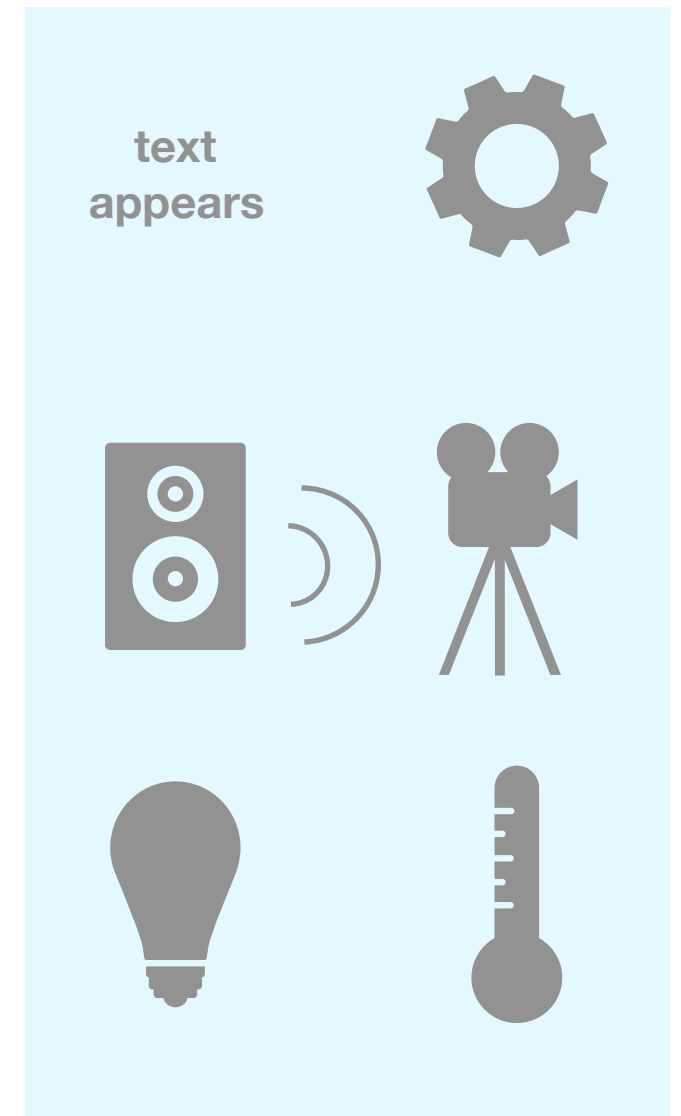
## inputs

information received by a sensor that triggers an output



## micro controller | computer

transfers the message from the sensor input into an output using code or an algorithm ( but sometimes there are boards that are already coded for you)



## outputs

actions that are triggered as a result of the input

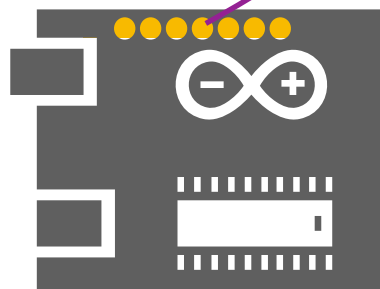
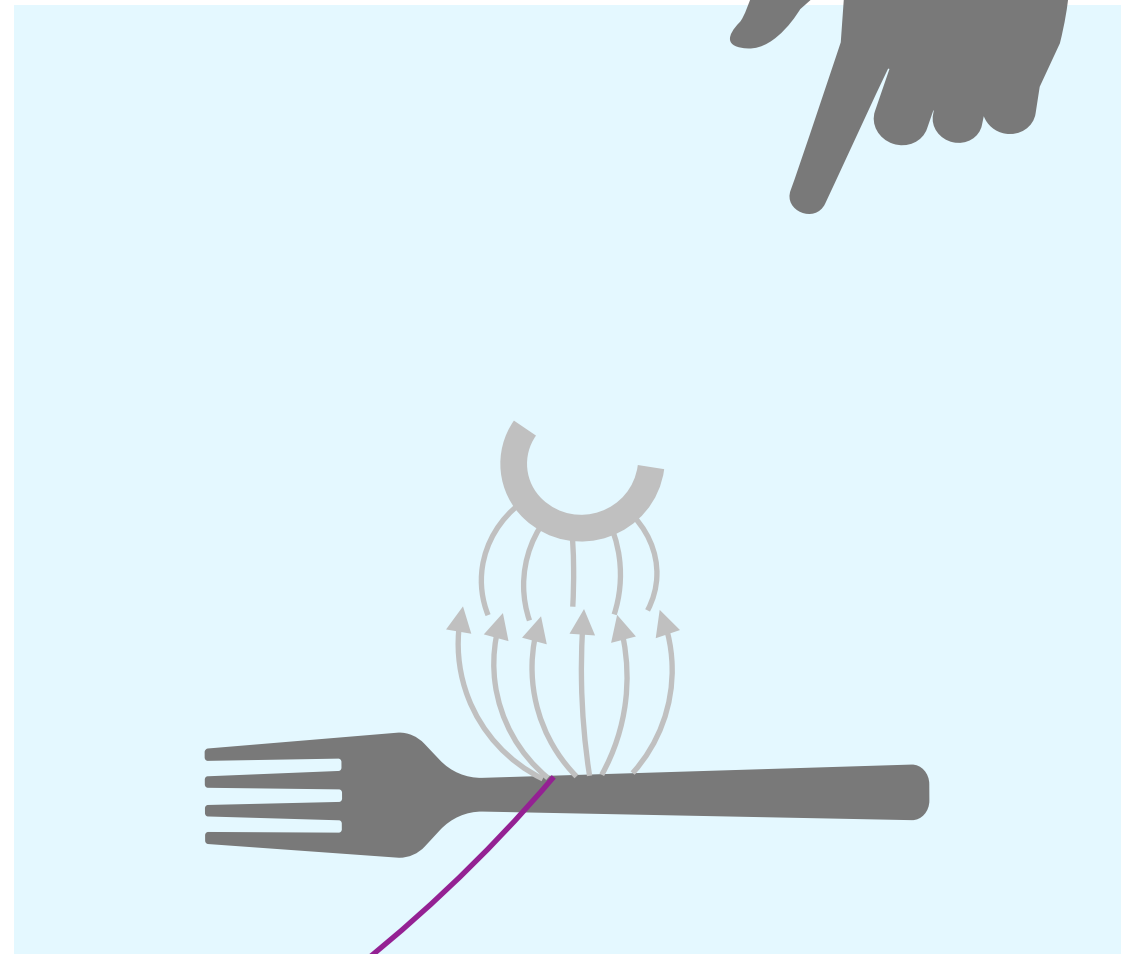
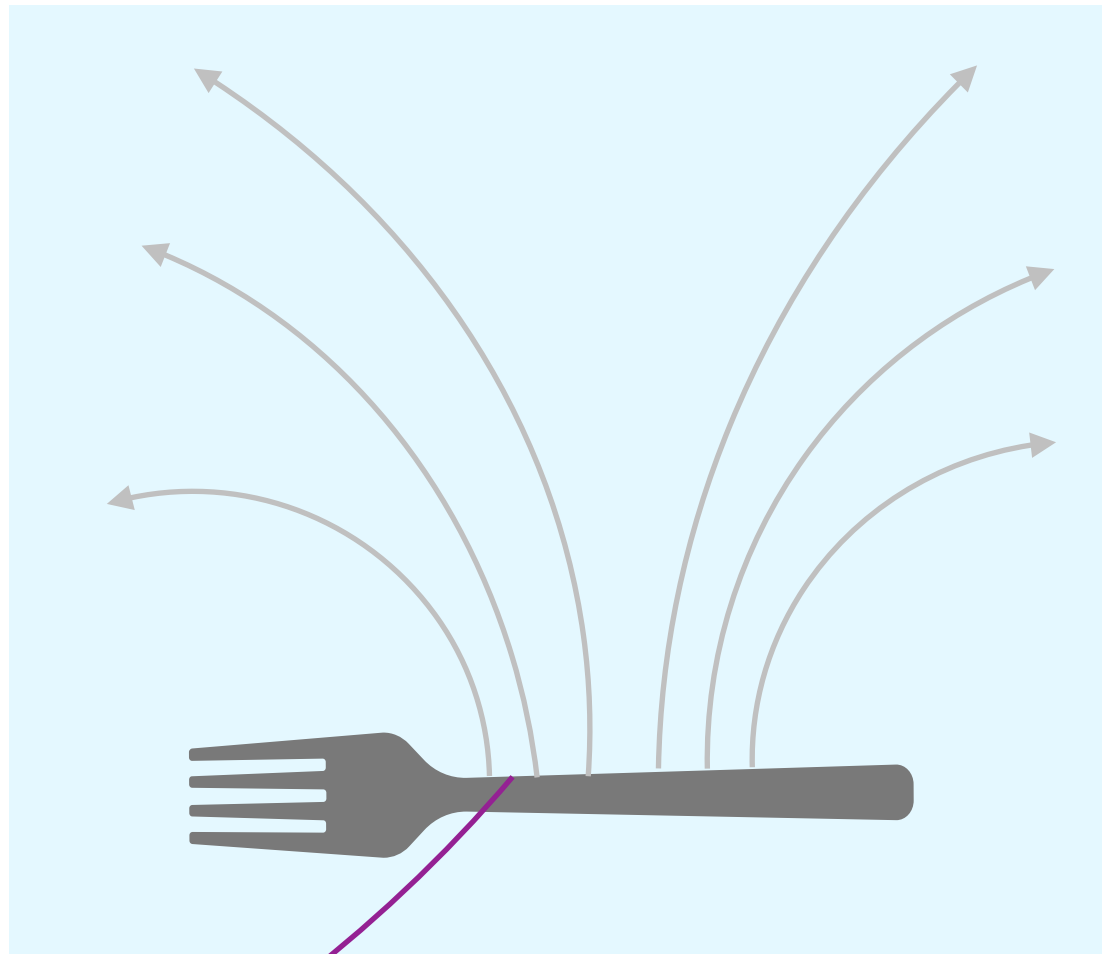


# what is capacitive touch and how does it function?

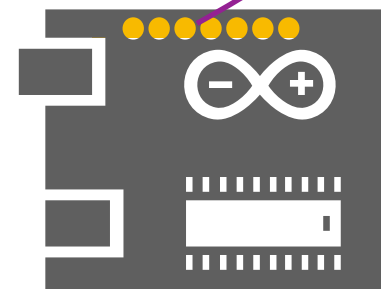
## capacitive sensing

detects nearby objects by sensing an electric field generated by a sensor, can detect anything that is conductive

*examples: in your smartphone screen or the trackpad on your laptop*



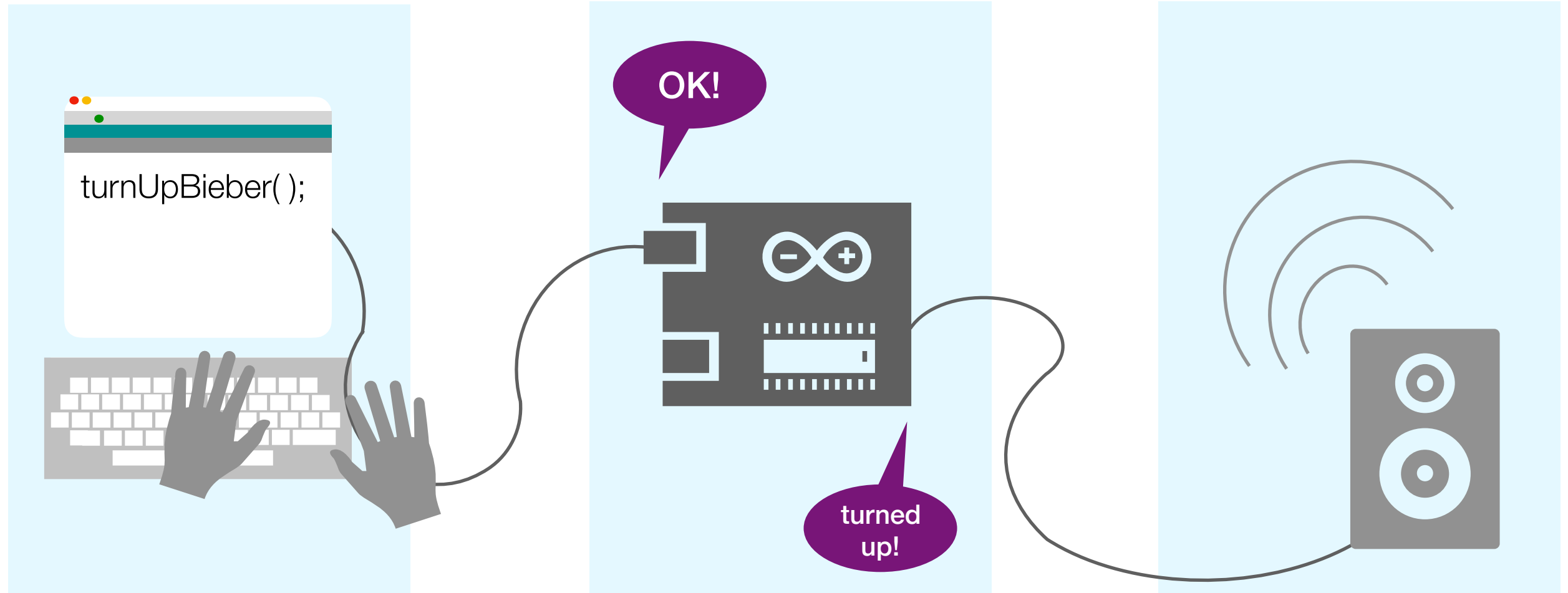
each electrode on the micro-controller generates a sensitive electric field. it can be connected to any conductive material.



your finger couples with the electrode's field and connects it to the earth, which the micro controller detects as a completed circuit.



# programming basics



## **create code**

type commands into a computer to tell it what to do. There are many coding languages, Arduino IDE is a common one.

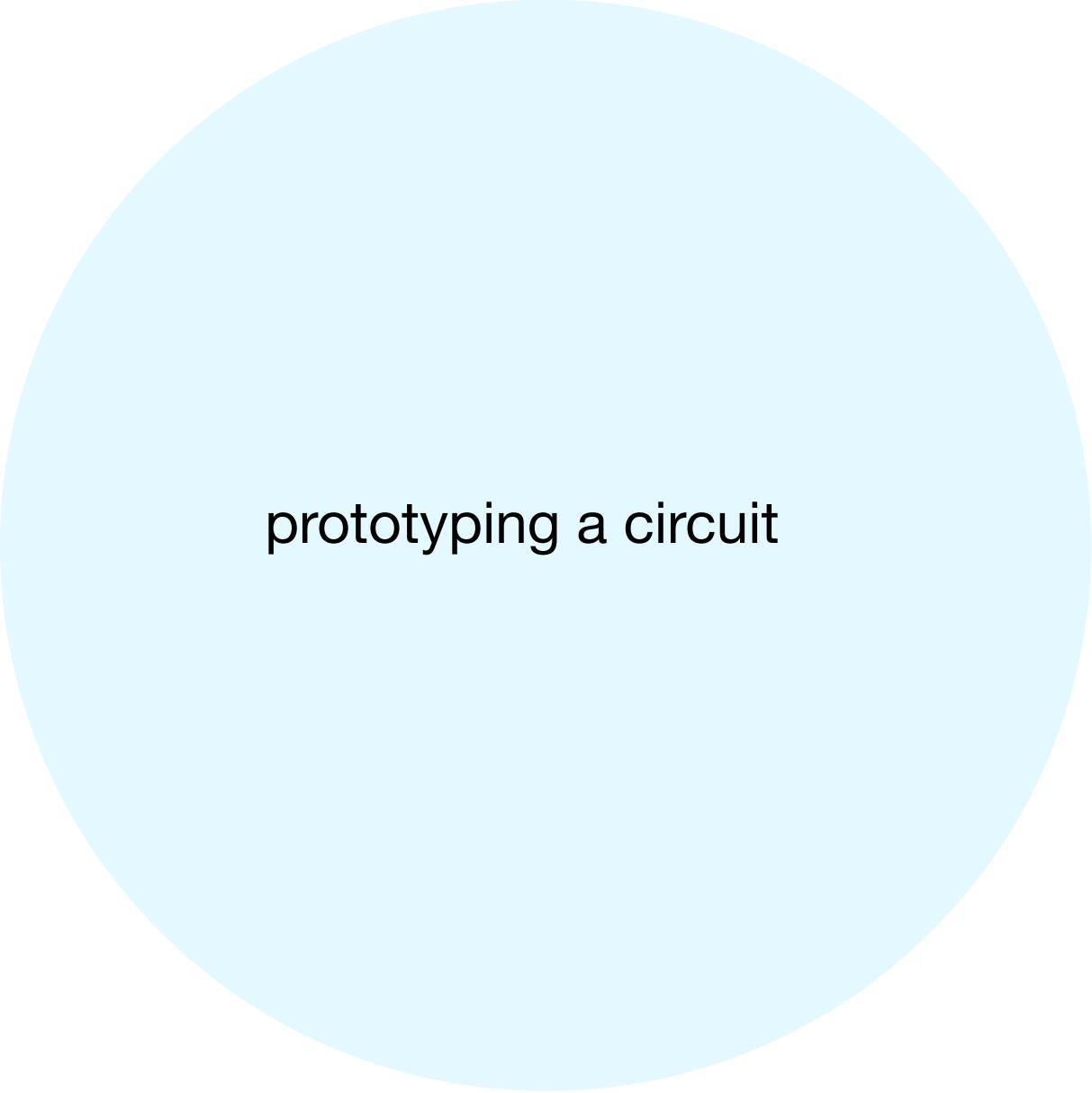
## **upload code**

the code tells the board what action to take.

## **execute code**

attach the micro controller to the output device, so it can execute the code.

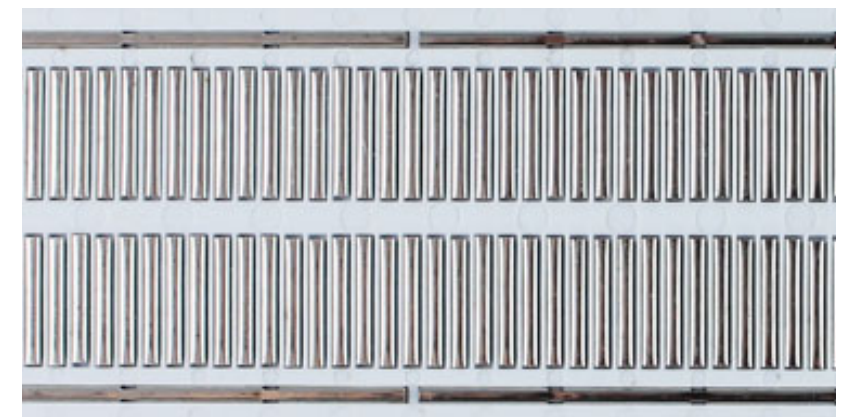
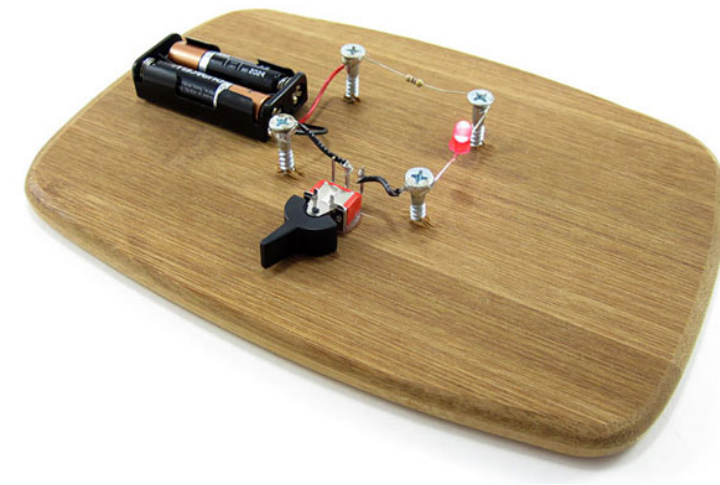
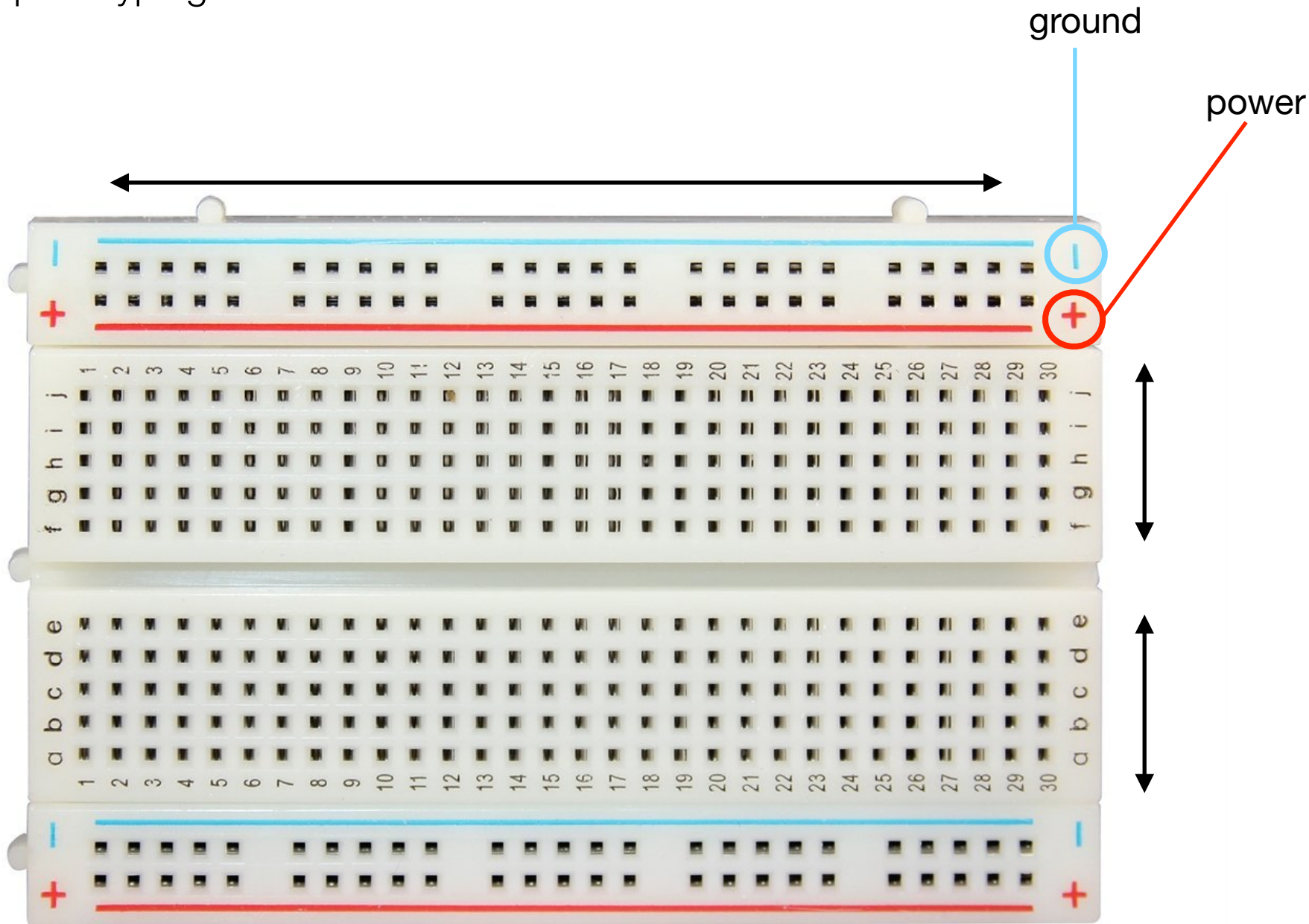




prototyping a circuit

## breadboards

prototyping an electronic circuit



back side of breadboard

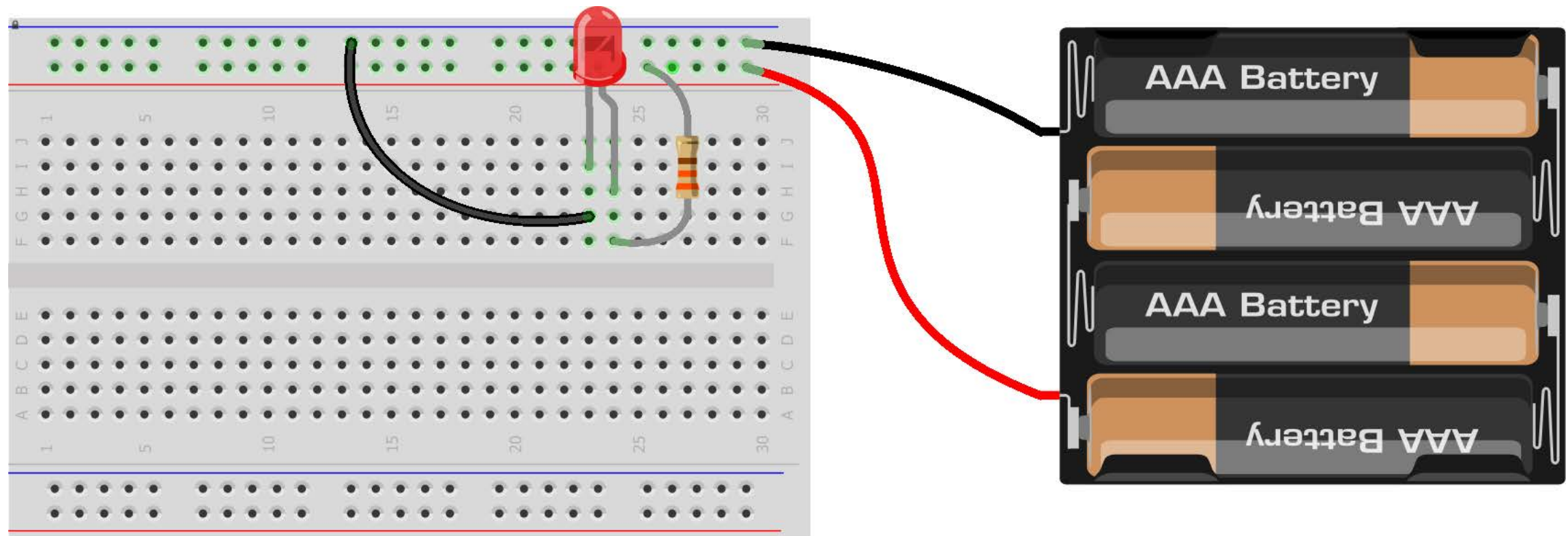
a temporary circuit board for testing and prototyping circuits

no soldering or buttered toast allowed, making circuit experiments faster, easier, and less tasty



## breadboards

example circuit and schematic



Made with  Fritzing.org

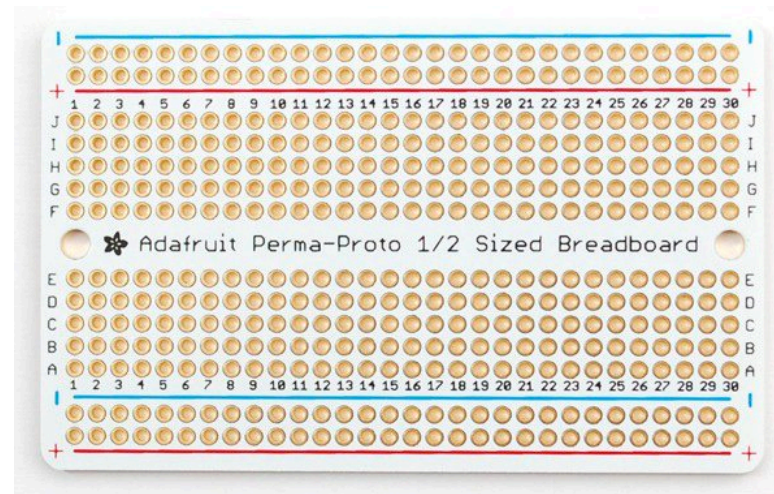
## permanent boards

perfboards and perma proto boards



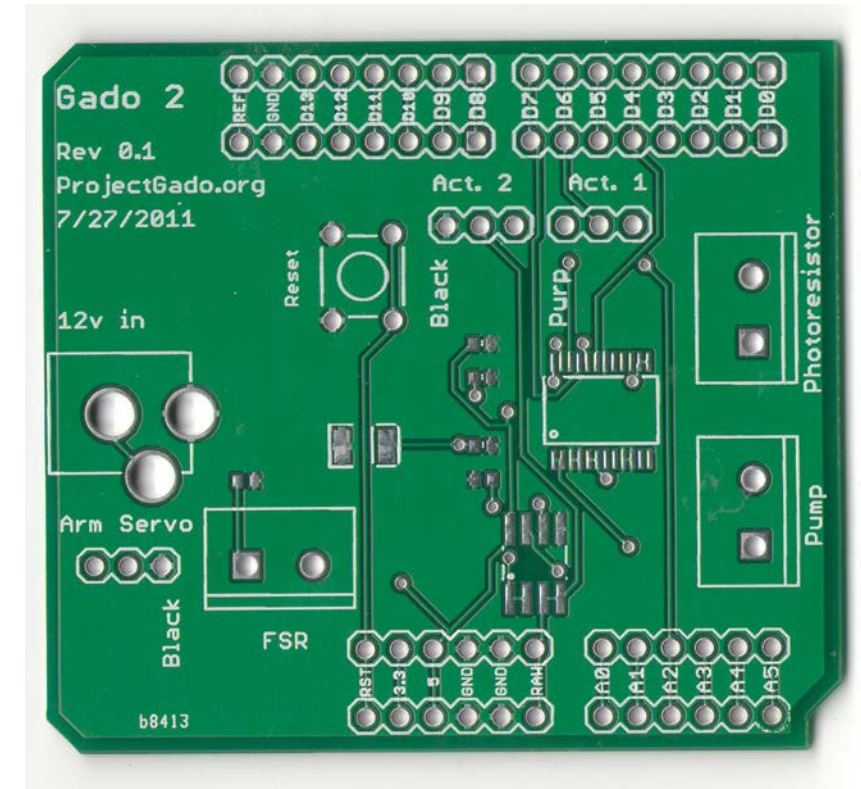
## perforated board

generic grid of holes  
surrounded by metal pads



## perma proto board

metal pads are reconnected  
in same configuration as  
breadboard, making  
transferring the circuit easy

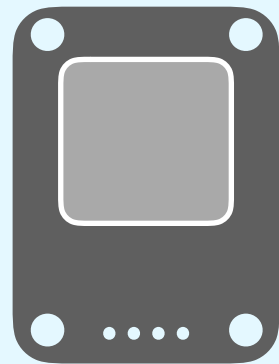


## user designed printed circuit board

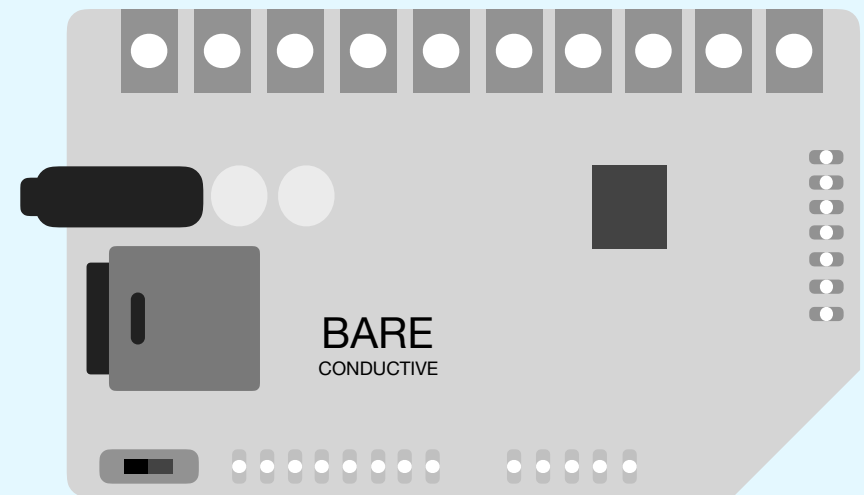
specialized board printed  
specifically for your project



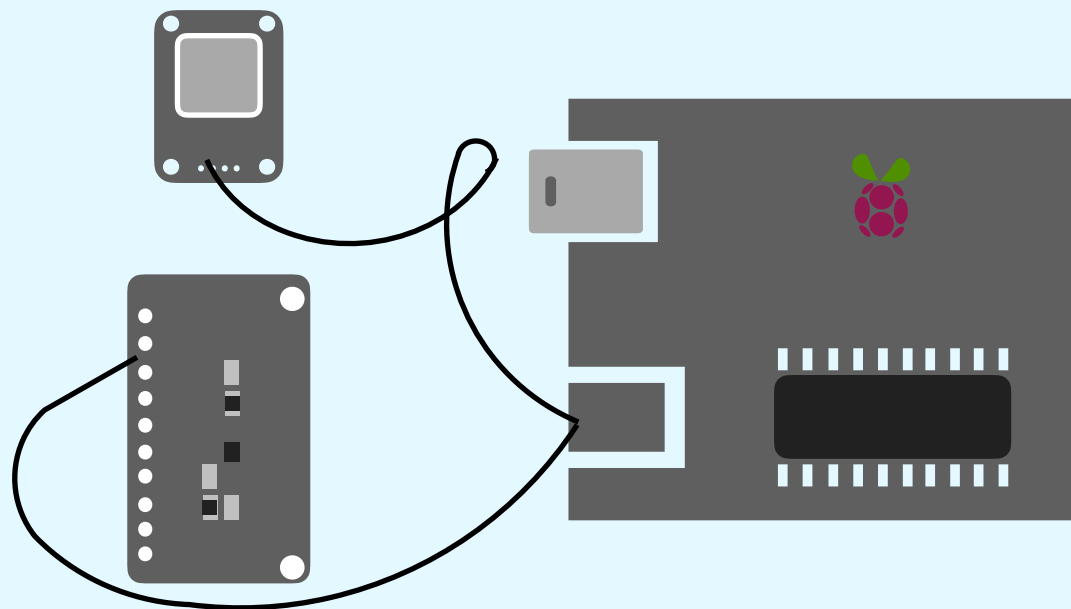
## types of capacitive touch sensor inputs



stand alone boards



bare conductive touch board

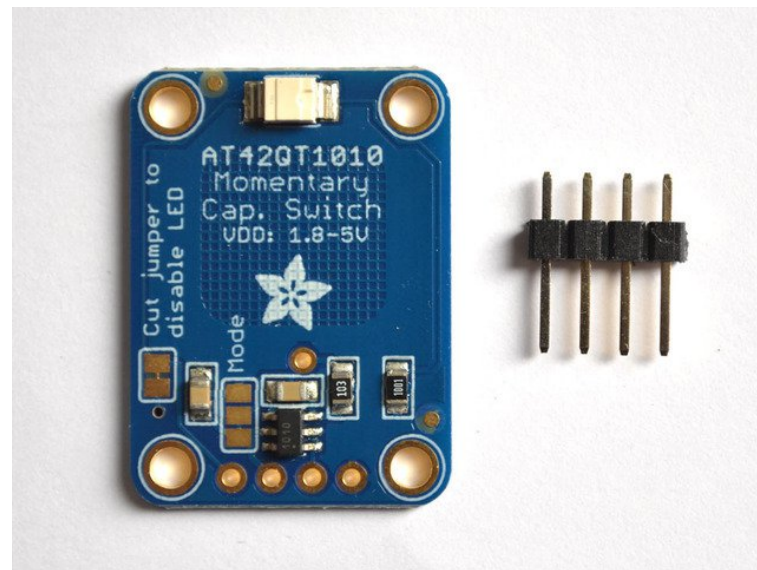


touch boards and shields/ hats  
paired with micro controllers

## stand alone boards

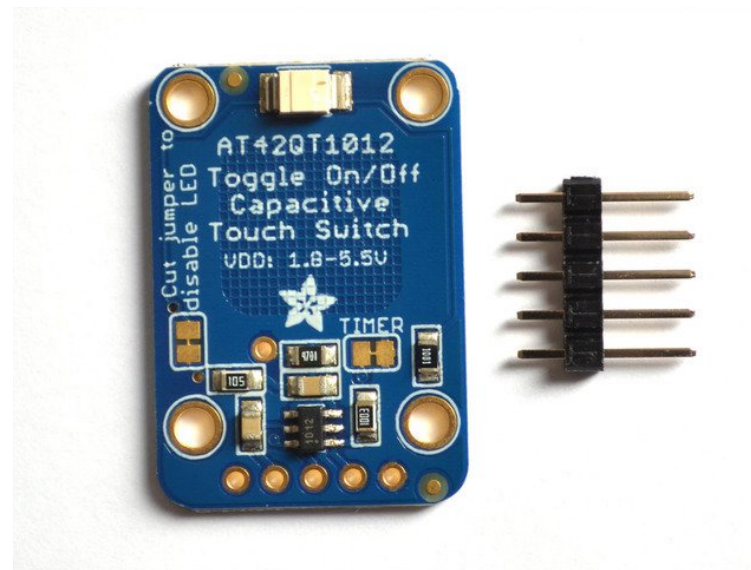
### momentary

Active for as long as the sensor area is touched.



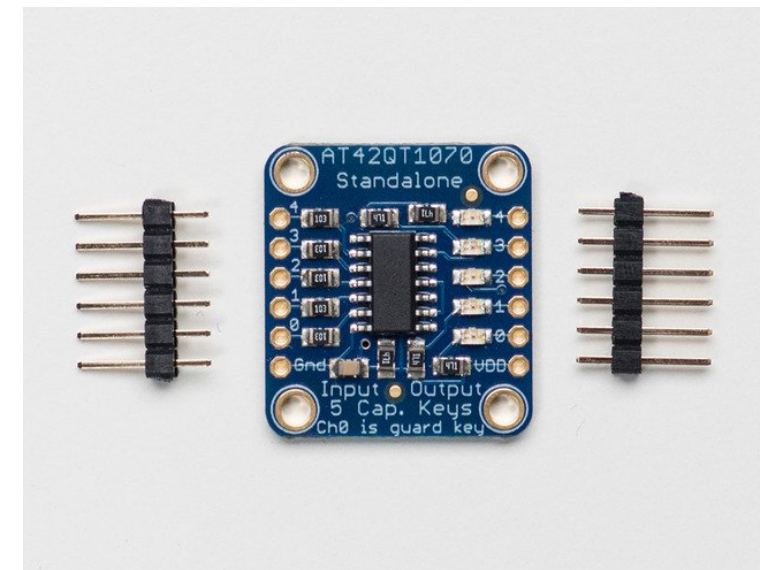
### toggle

Becomes active when touched and remains active until touched again.



### 5-pad momentary

Combines 5 momentary switches into one breakout. Sensor pads are external.



### sense-pad

Momentary and Toggle boards each one sense pad that can be extend with wire to any conductive material.

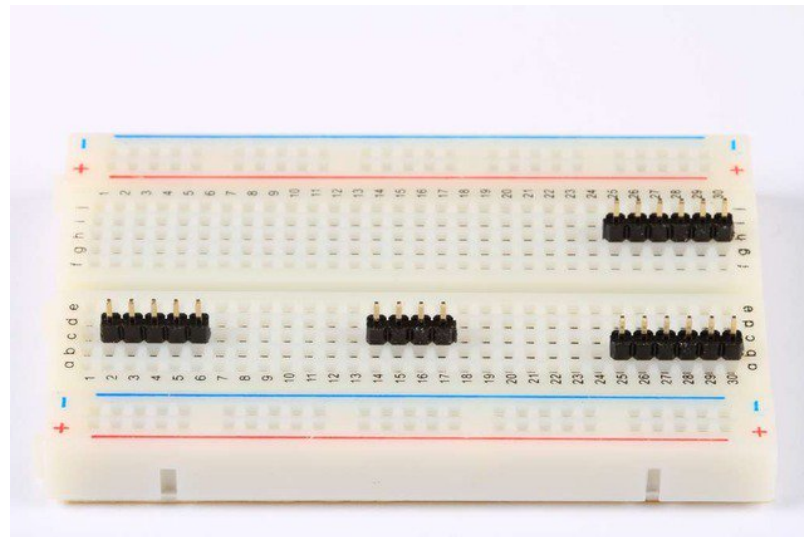


### substituting sense-pads

Attach a connecting wire to any conductive object or surface (cast metal) that will become touch sensitive. Larger surfaces are more sensitive.

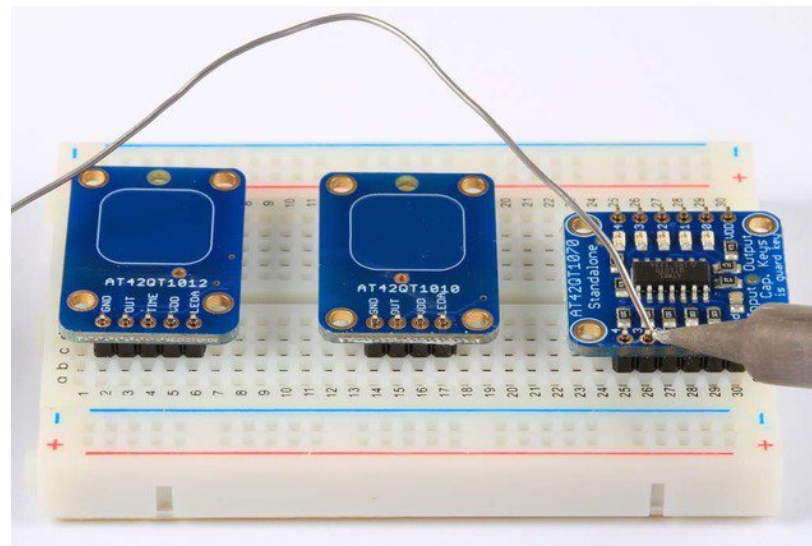


# stand alone boards assembly



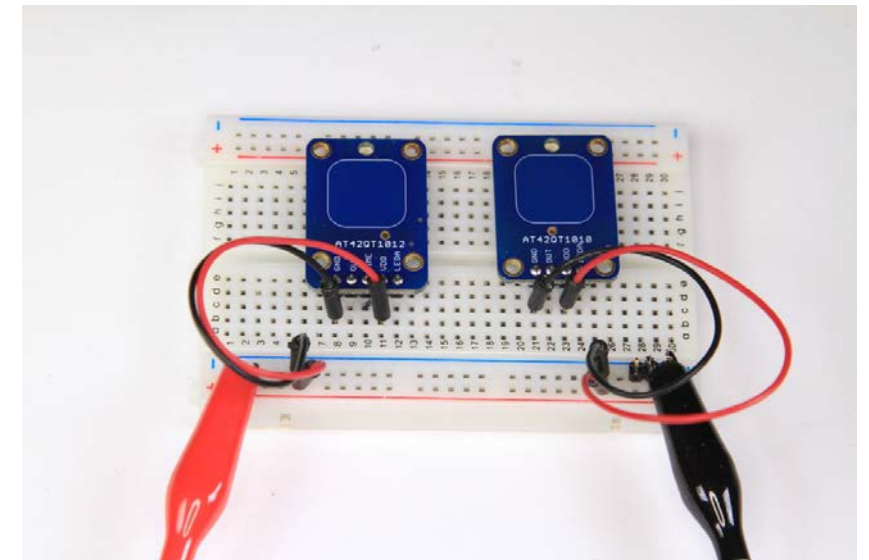
## 1. position headers on board

Place breakout board over header pins on breadboard.



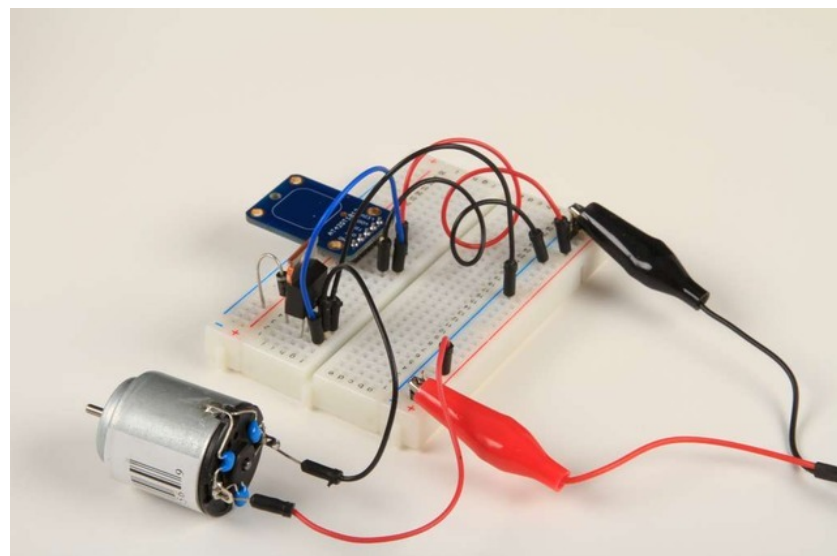
## 2. solder

Solder each pin for a solid electrical contact.



## 3. wiring

Both toggle and momentary boards can be powered by anything from 1.8V-5.5V DC. Connect ground to GND and the positive + to VDD.



## 4. adding different outputs to your circuit (optional)

Outputs of touch switches are 'active high'. You can use them like a positive logic signal, coding them to

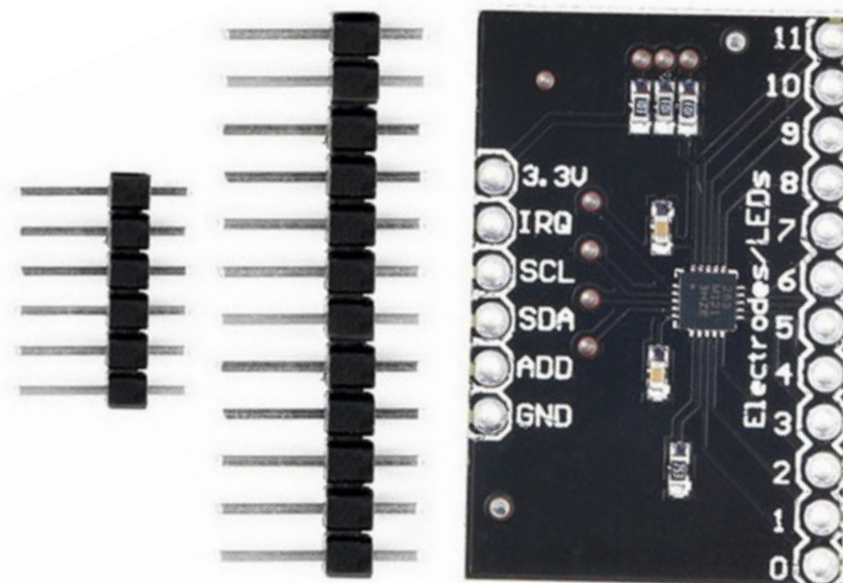
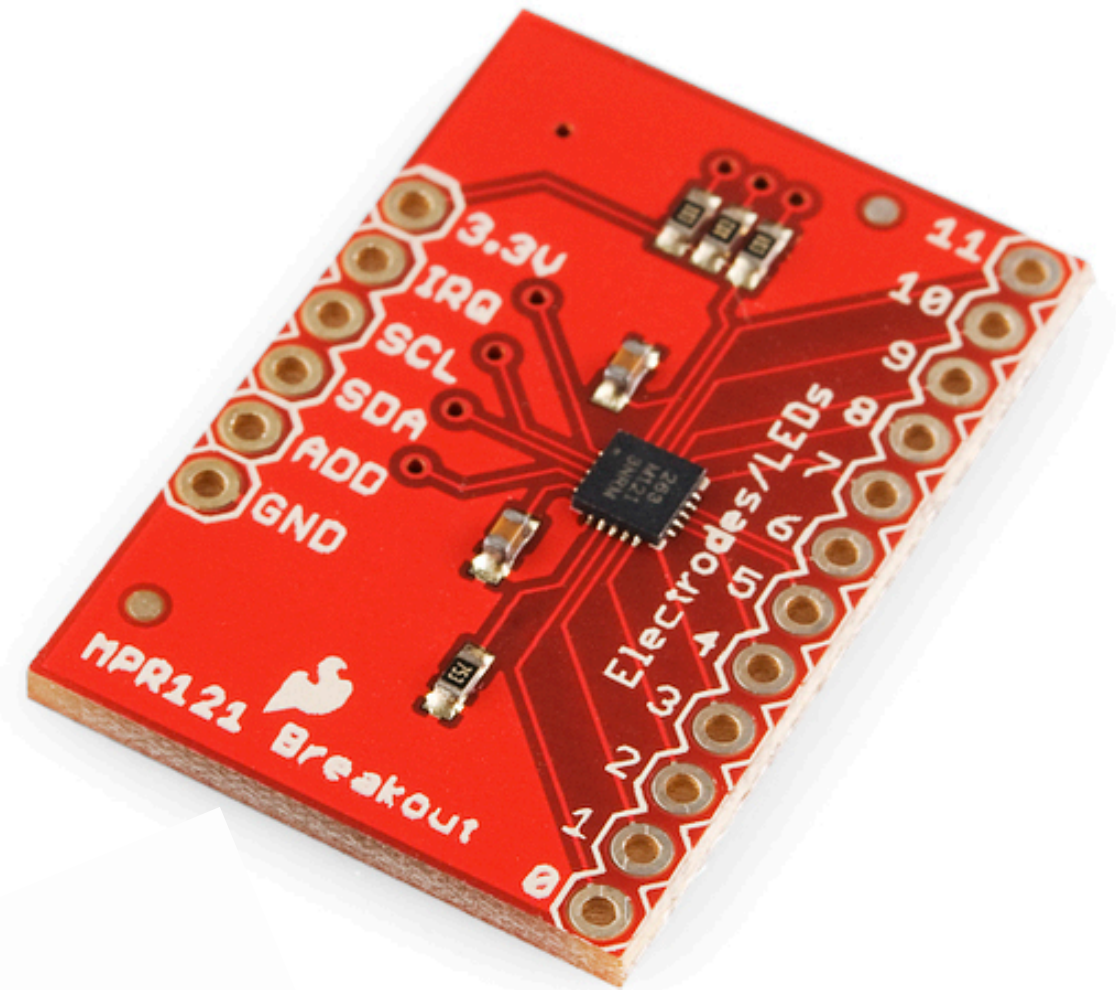
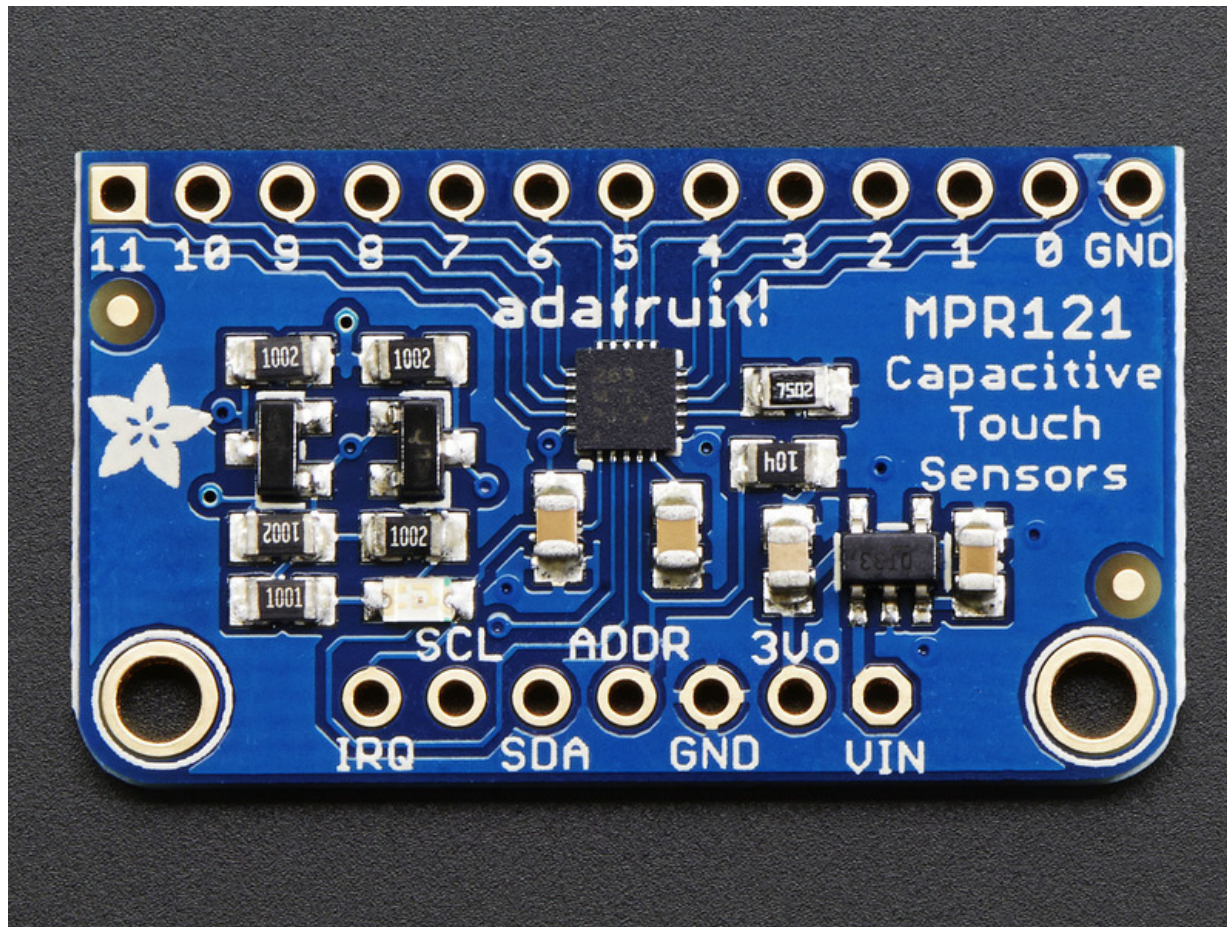
## 5. admire

Take a moment, sit back, admire what you've done



## multi key sensors

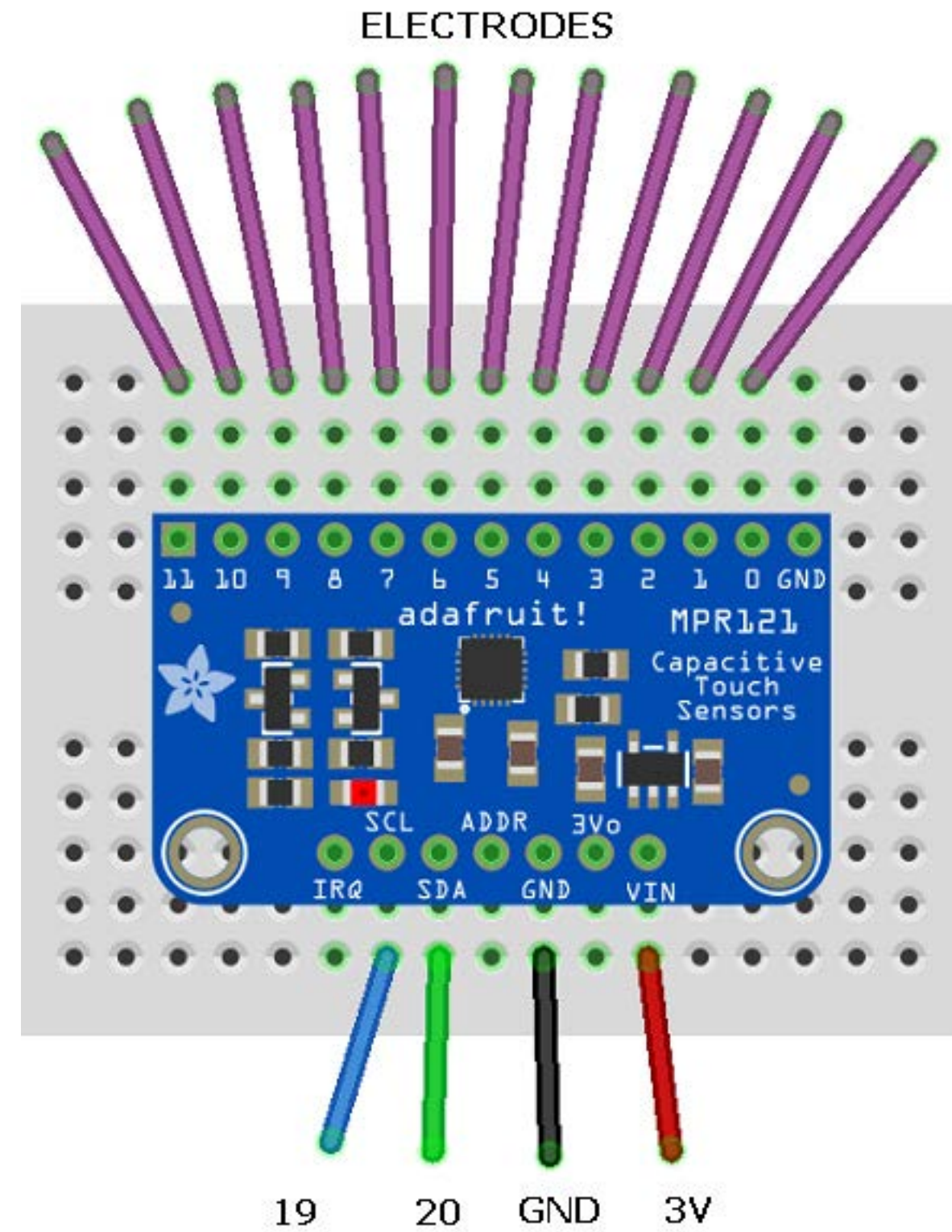
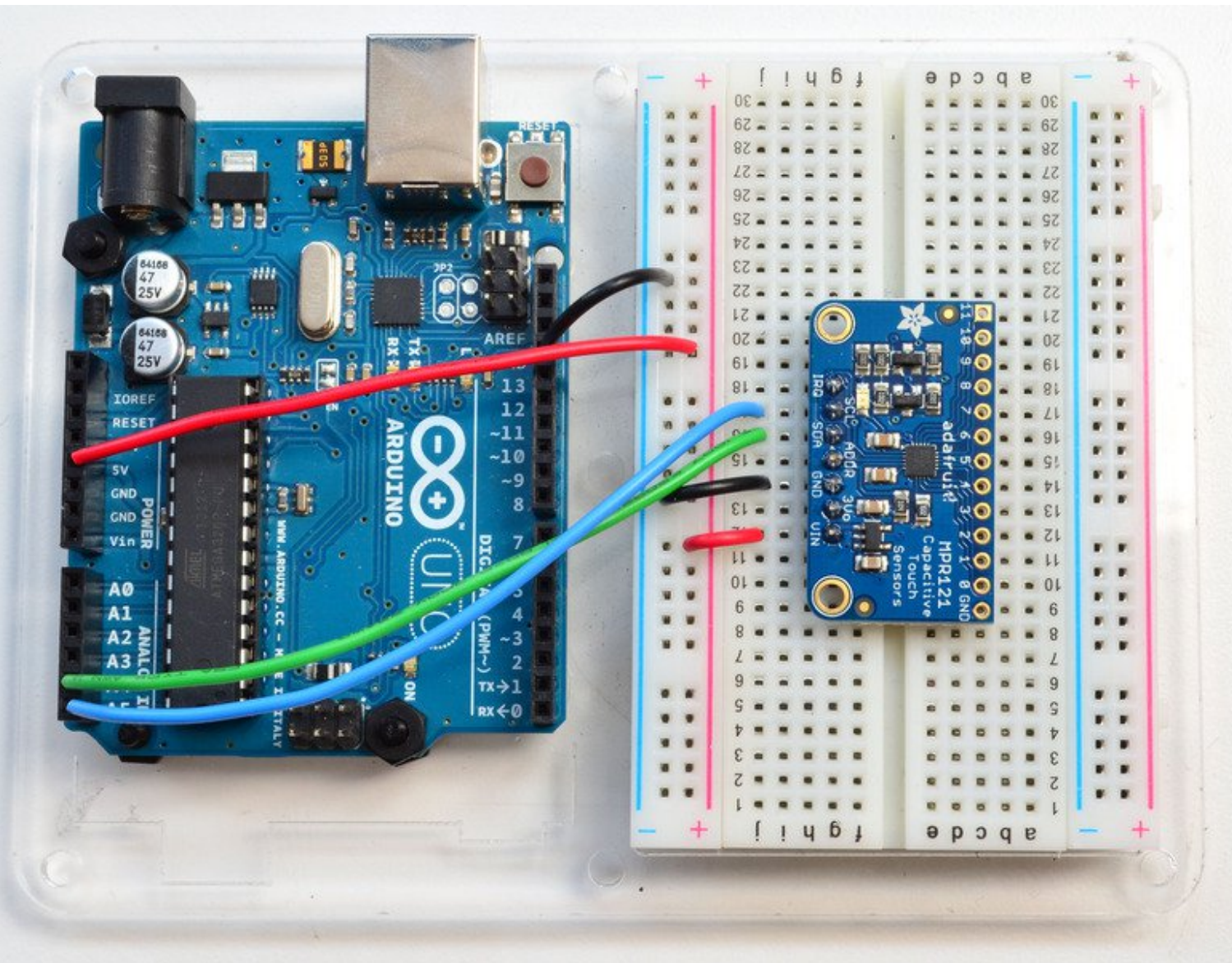
MPR121





## multi key sensor

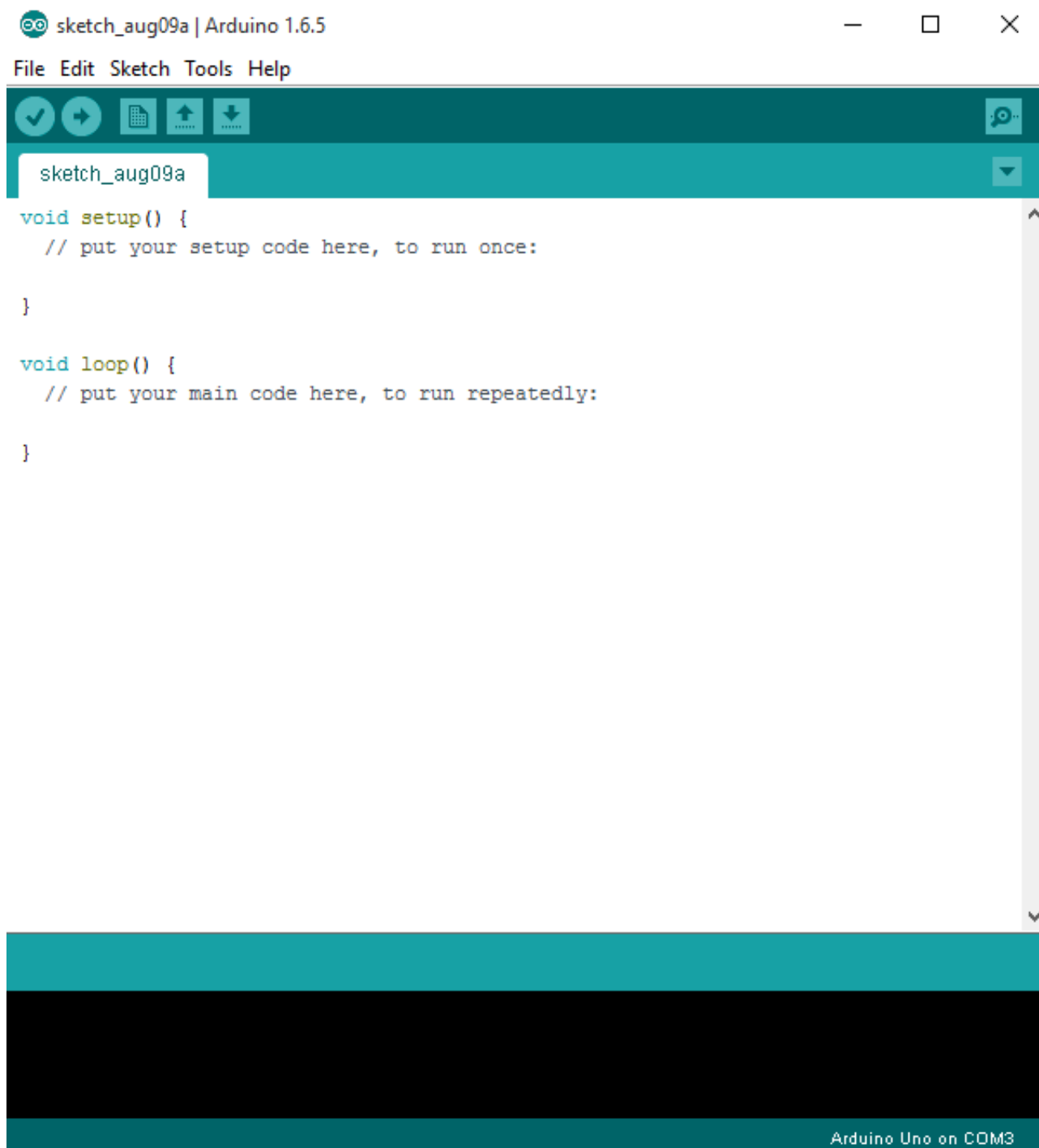
MPR121 with Arduino





# multi key sensors

pairing with micro controllers: basic coding



The screenshot shows the Arduino IDE interface. The title bar reads "sketch\_aug09a | Arduino 1.6.5". The menu bar includes "File", "Edit", "Sketch", "Tools", and "Help". The toolbar contains icons for checking, running, uploading, and downloading. The sketch name "sketch\_aug09a" is displayed in the top right. The code editor contains the following C++ code:

```
void setup() {  
  // put your setup code here, to run once:  
  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
  
}
```

The status bar at the bottom indicates "Arduino Uno on COM3".



The screenshot shows the MPR121test library documentation and code. The title bar reads "MPR121test". The documentation includes the following text:

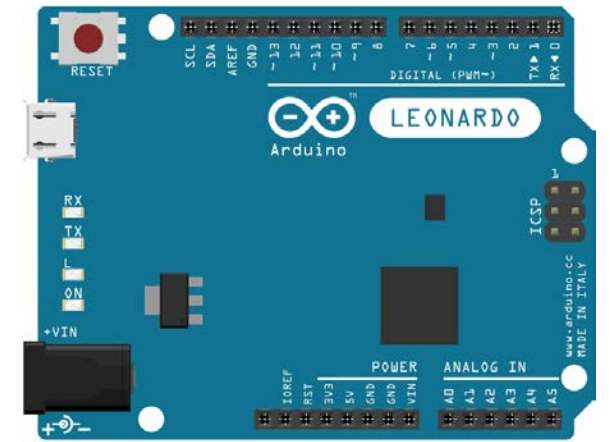
\*\*\*\*\*  
This is a library for the MPR121 12-channel Capacitive touch sensor  
  
Designed specifically to work with the MPR121 Breakout in the Adafruit shop  
----> <https://www.adafruit.com/products/>  
  
These sensors use I2C communicate, at least 2 pins are required to interface  
  
Adafruit invests time and resources providing this open source code, please support Adafruit and open-source hardware by purchasing products from Adafruit!  
  
Written by Limor Fried/Ladyada for Adafruit Industries.  
BSD license, all text above must be included in any redistribution  
\*\*\*\*\*/

```
#include <Wire.h>  
#include "Adafruit_MPR121.h"  
  
// You can have up to 4 on one i2c bus but one is enough for testing!  
Adafruit_MPR121 cap = Adafruit_MPR121();  
  
// Keeps track of the last pins touched  
// so we know when buttons are 'released'  
uint16_t lasttouched = 0;  
uint16_t currntouched = 0;  
  
void setup() {  
  while (!Serial);           // needed to keep leonardo/micro from starting too fast!  
  
  Serial.begin(9600);  
  Serial.println("Adafruit MPR121 Capacitive Touch sensor test");  
  
  // Default address is 0x5A, if tied to 3.3V its 0x5B  
  // If tied to SDA its 0x5C and if SCL then 0x5D  
  if (!cap.begin(0x5A)) {  
    Serial.println("MPR121 not found, check wiring?");  
  }
```



# bare conductive touch board overview

modeled after the Arduino Leonardo board



12 touch sensors/ electrodes

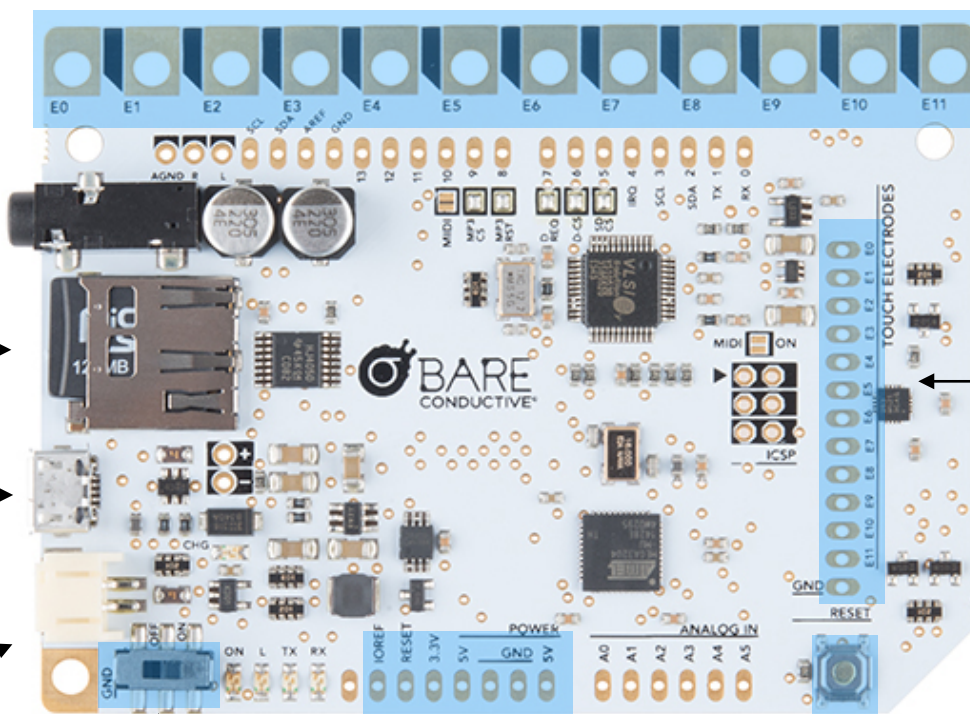


3.5 mm audio jack

micro SD card reader  
up to 32GB

USB mini connector

3.7V LiPo battery  
charger



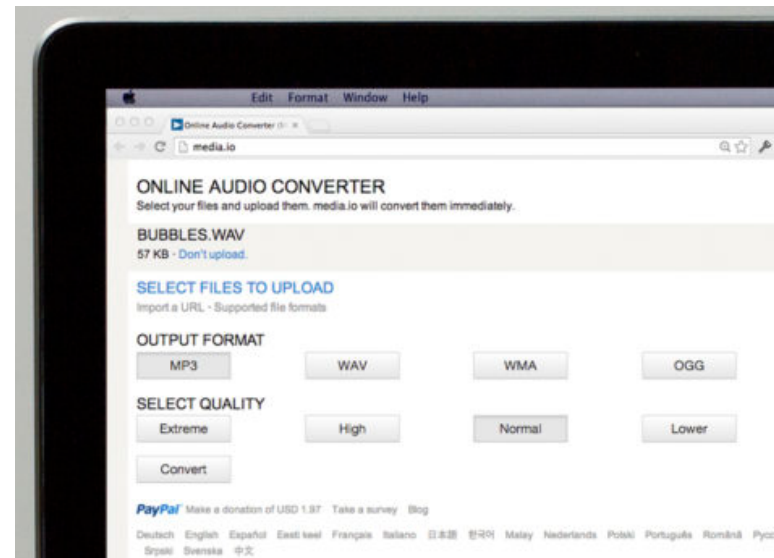
electrode  
solder pads

reset button

on/off switch

power source  
connections:  
3.0 - 5.5V DC

# bare conductive touch board using MP3 player



## 1. record audio

You can record your own mp3 tracks or download sounds from free sites like [freesound.org](http://freesound.org).

The Sony Zoom H1 Handy is an affordable and professional handheld recorder.

## 2. edit & format tracks

Edit your sound files in a program like Adobe Audition or Audacity (free).  
[mp3cut.net](http://mp3cut.net) is useful for cropping tracks.

Files must be in *.mp3 format*. To convert from *.wav*, you can use a site like [www.media.io](http://www.media.io).

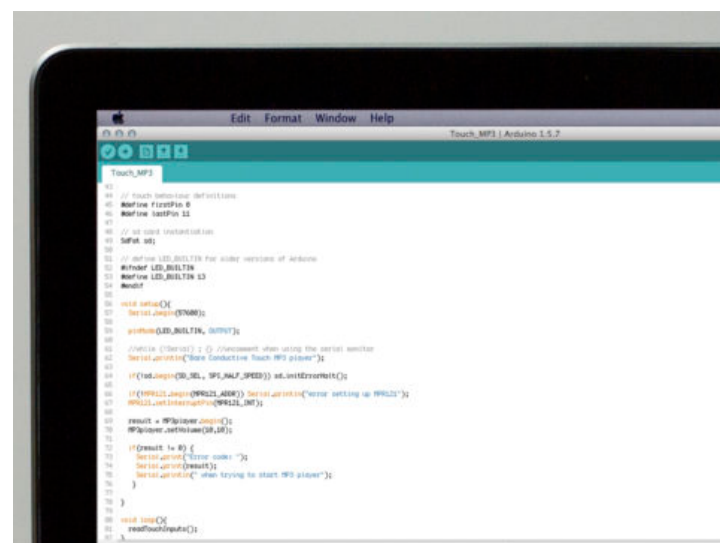
## 3. label & load on micro SD card

Use a micro SD card adapter to insert the card into your computer.

Label tracks as:

TRACK000.mp3...for electrode E0  
TRACK001.mp3...for electrode E1  
TRACK011.mp3...for electrode E11

These names will allow the touch board to read the files properly.



## 4. changing the volume settings using code

Add a line of code: `MP#player.setVolume(X,Y)`

X is the left channel volume, Y is the right channel volume

The lower the value, the higher the volume.

(0,0) is the maximum

(254, 254) is silent

The code can go anywhere, but must be after `MP3player.begin();`



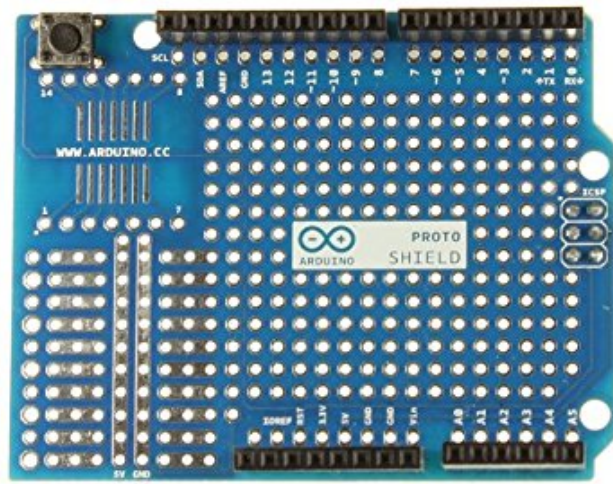
## **bare conductive touch board**

adding shields

### **shields**

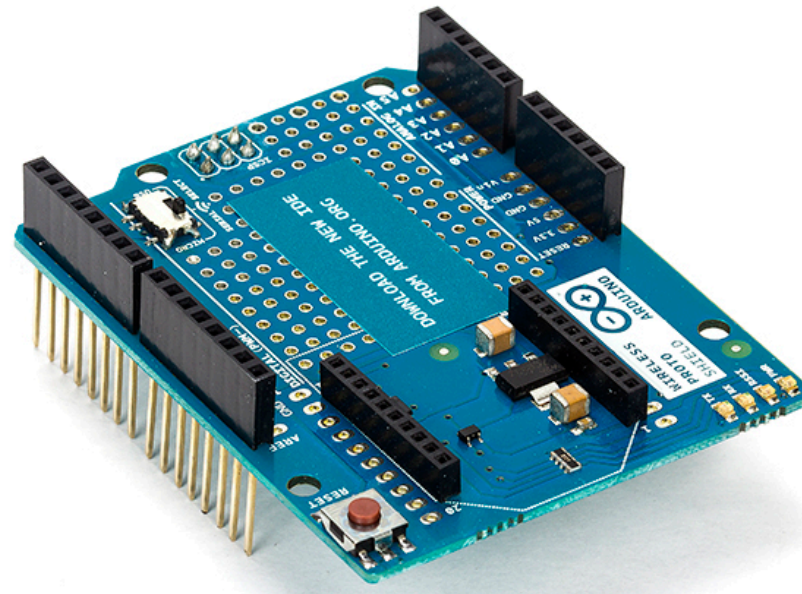
Boards that can be plugged on top of the main micro controller, extending their capabilities. Easy to mount and cheap to purchase.

**proto shield**



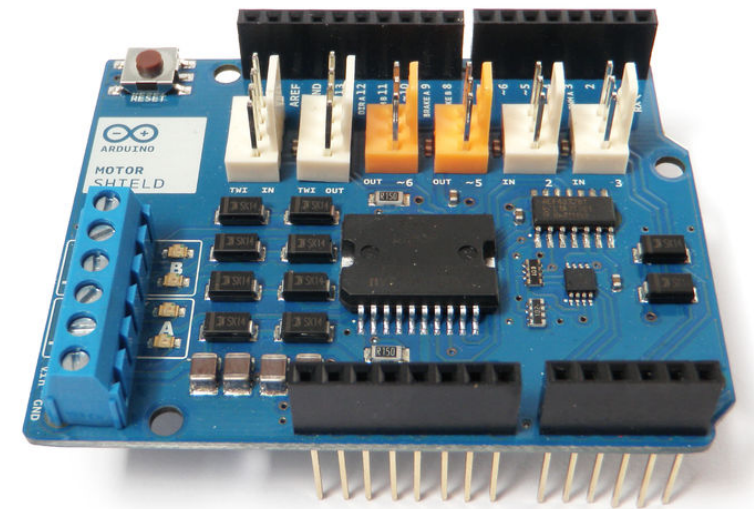
- Design custom circuits and extend capabilities of touch board
- Add a volume knob (potentiometer)

**motor shield**



- Can change a touch event into a physical movement, i.e. initiate a motor
- Must disable MP3 function on touch board to use

**wireless proto shield**

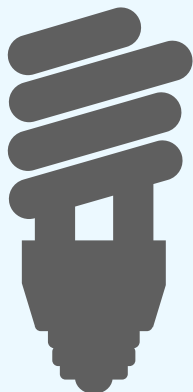


- Allows touch board to communicate wirelessly using a wireless module
- Can send and receive touch data from a remote location
- Great for installations that are hard to reach with cables

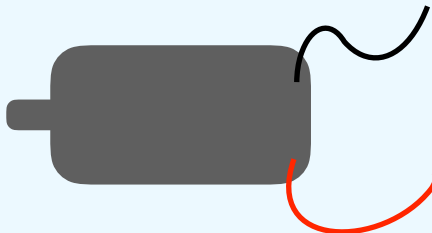
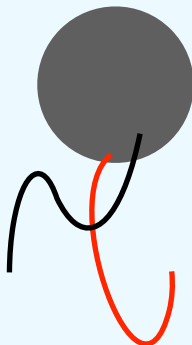
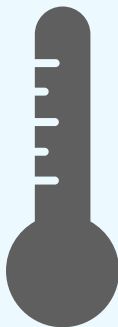
options for outputs



audio



LEDs | lights

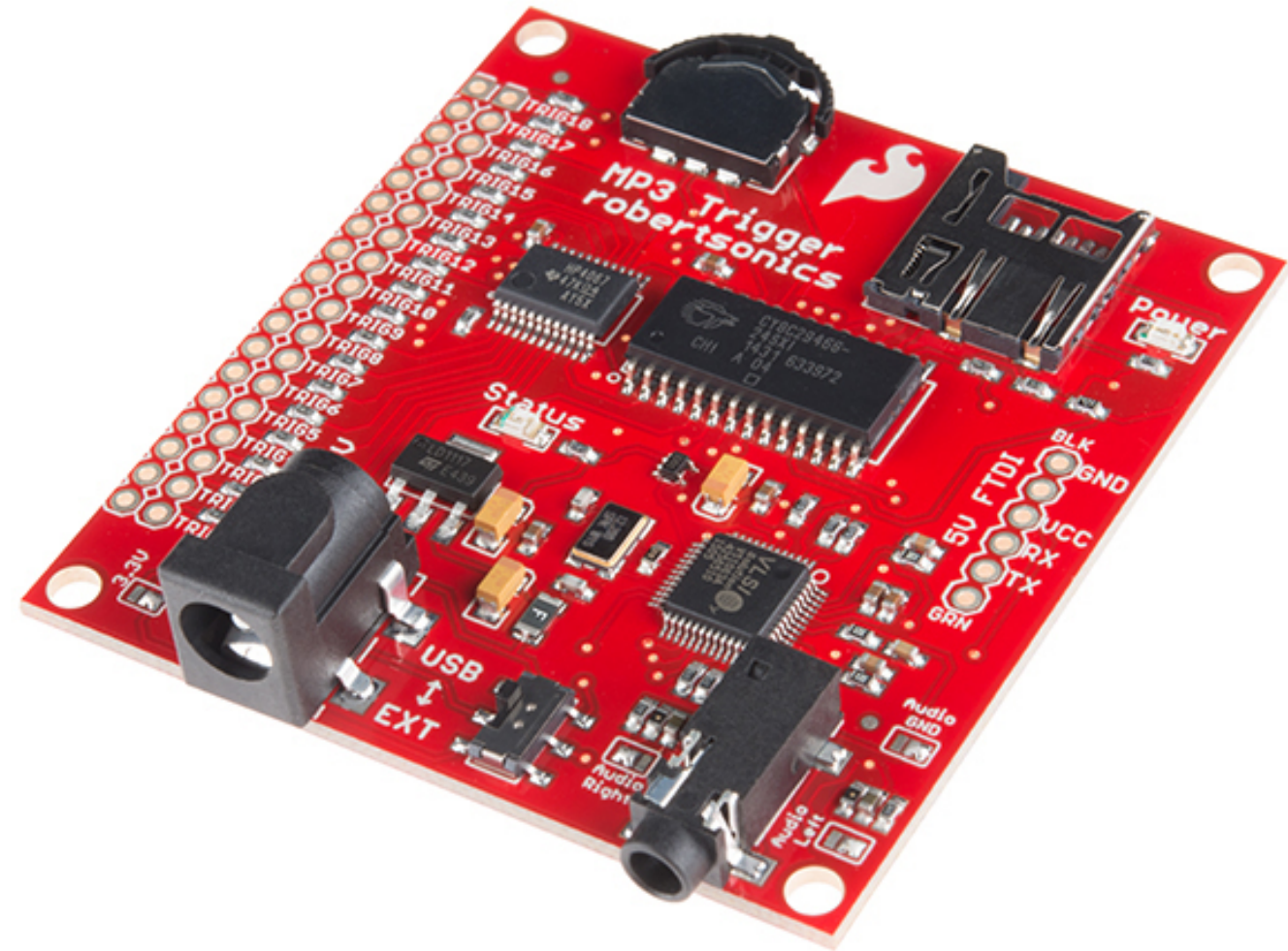
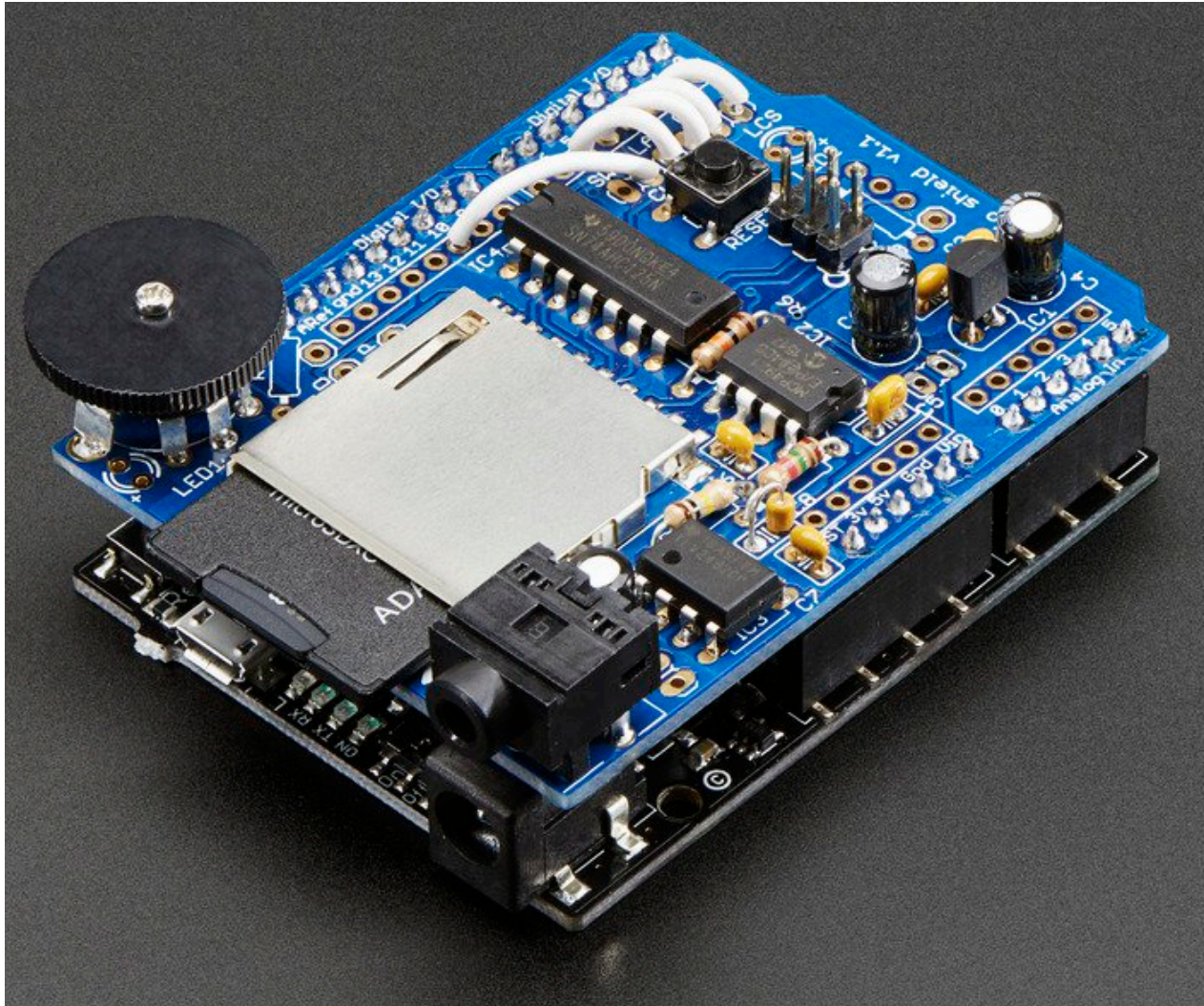


heat | vibration | motor | etc...



sound

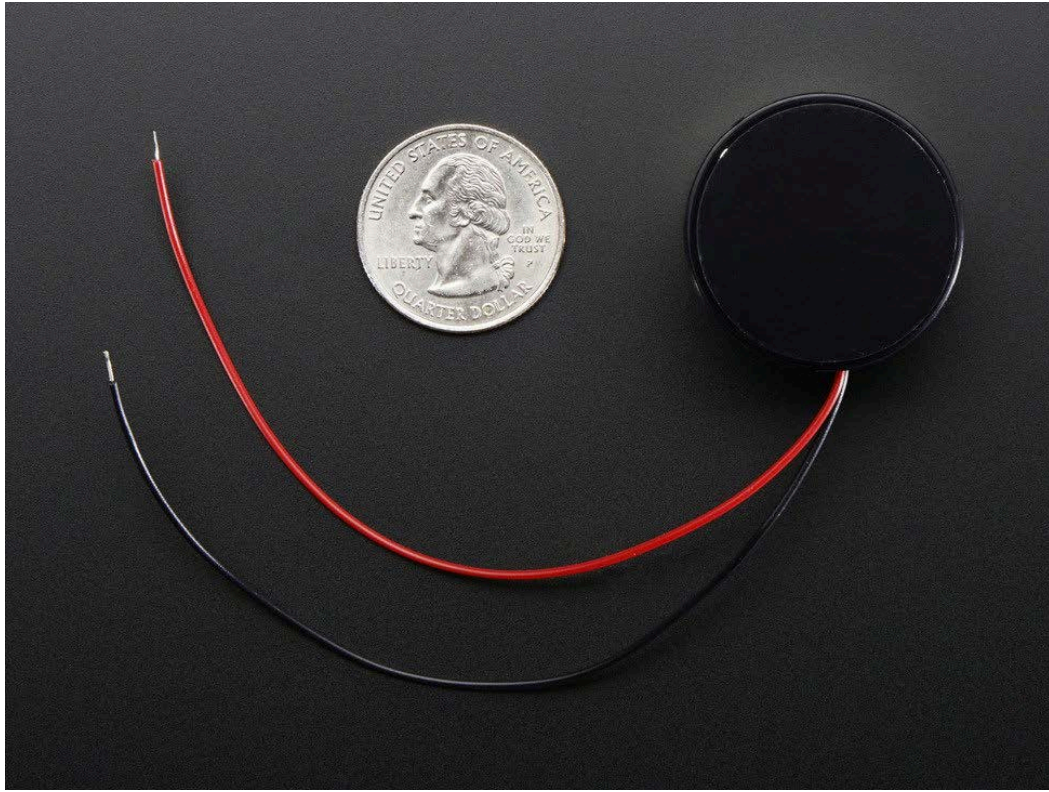
WAV and MP3 trigger shields





# sound

## types of speakers

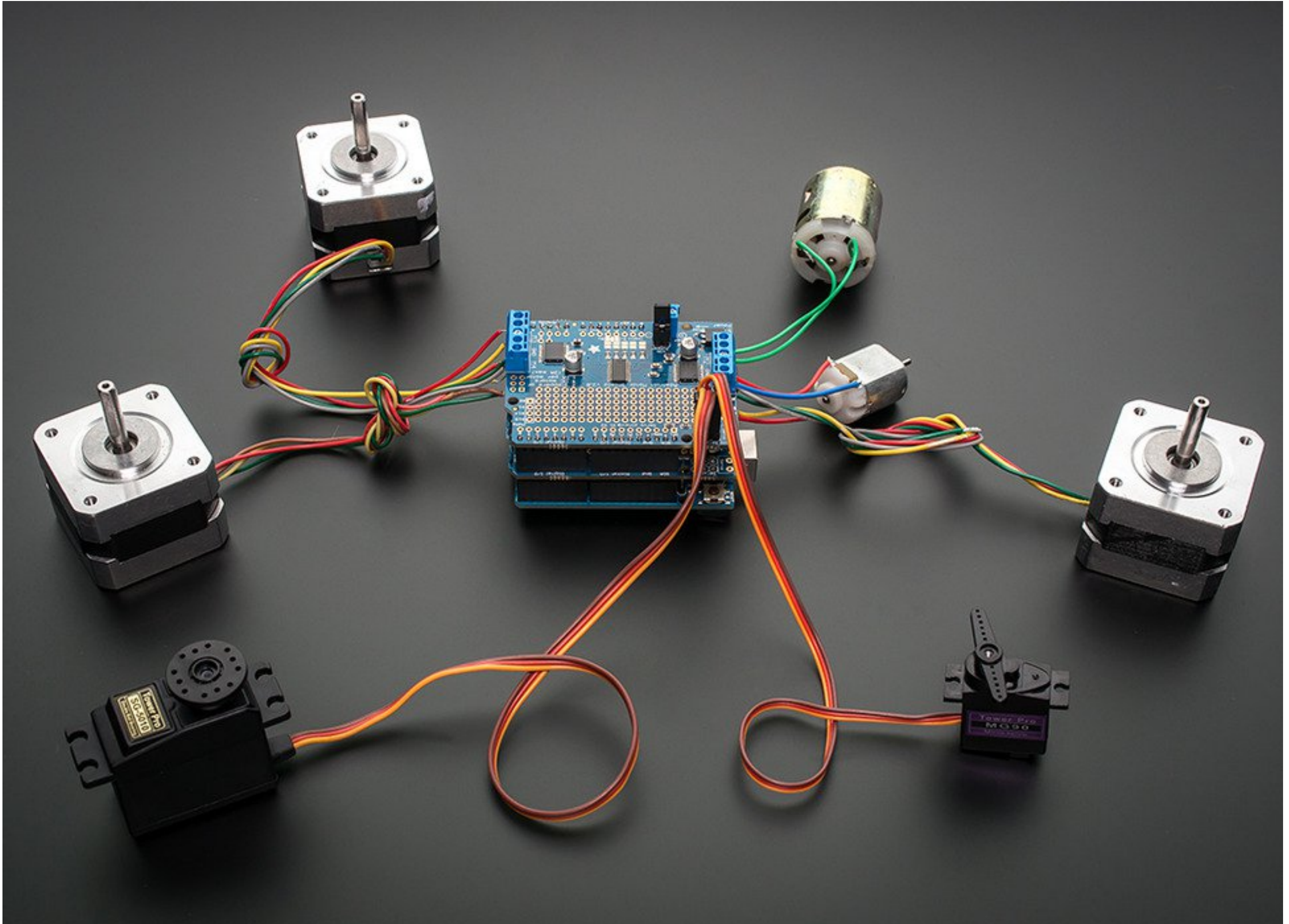




light



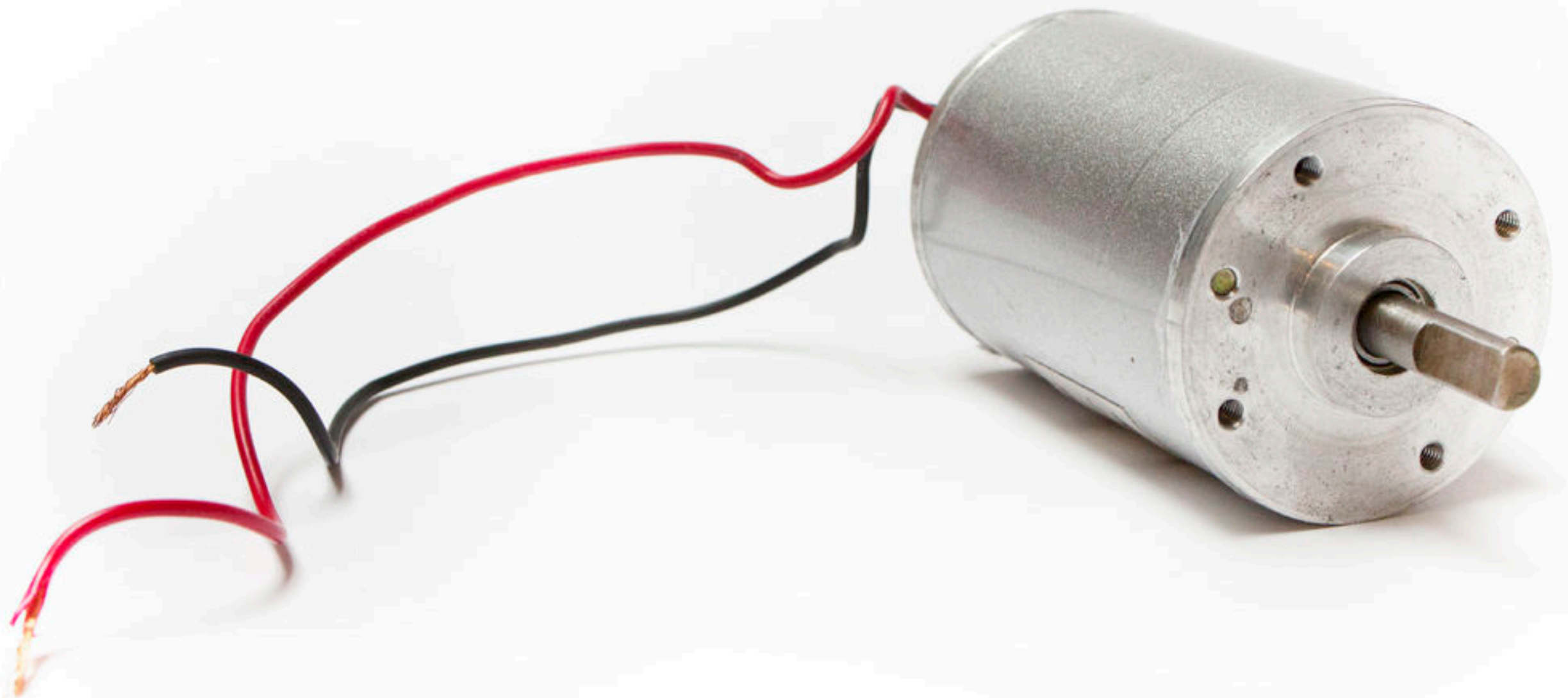
## movement | motors



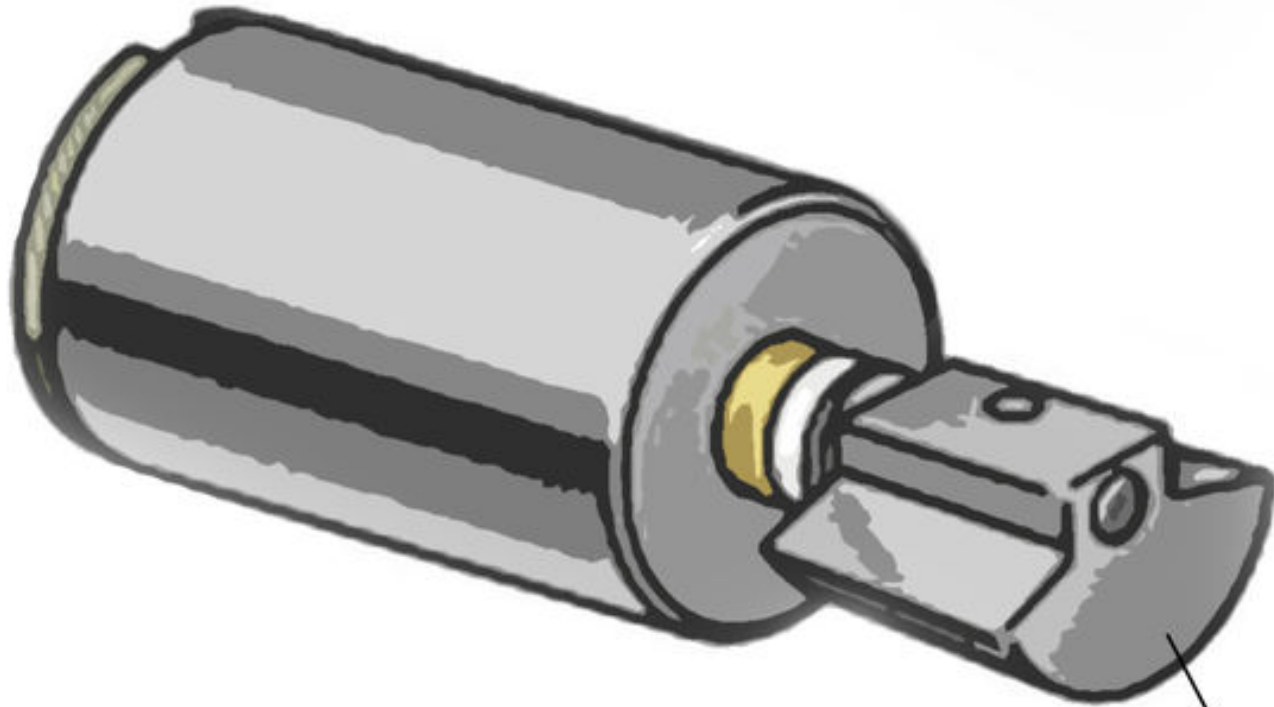


## movement

direct current (DC) motors



movement  
vibration motor



COUNTERWEIGHT IS FIXED AT  
THE END OF THE ROTOR, WHEN  
THE ROTOR SPINS, IT THROWS  
THE MOTOR OUT OF BALANCE  
CAUSING IT TO SHAKE.



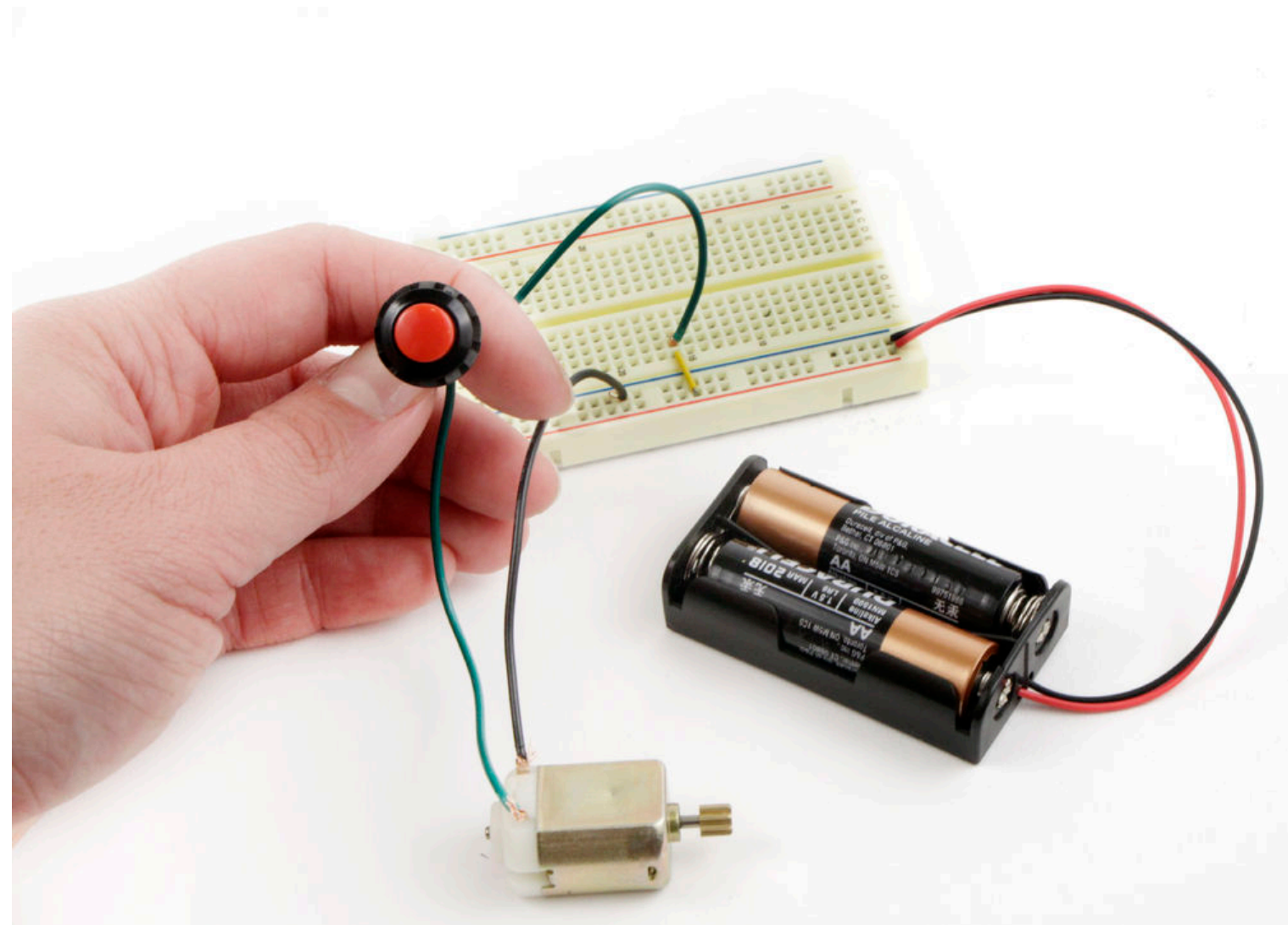
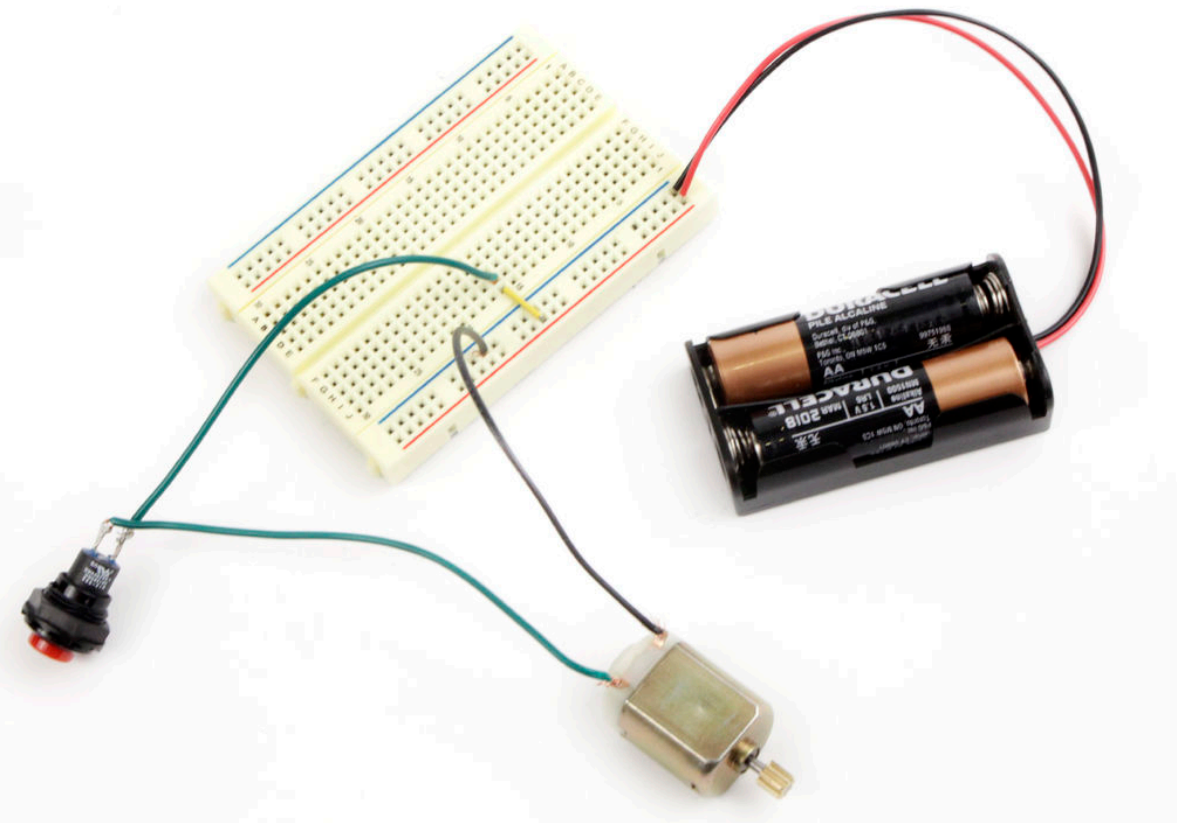
**movement**

vibrating mini disc



## movement

using DC or vibrating motors without a micro controller



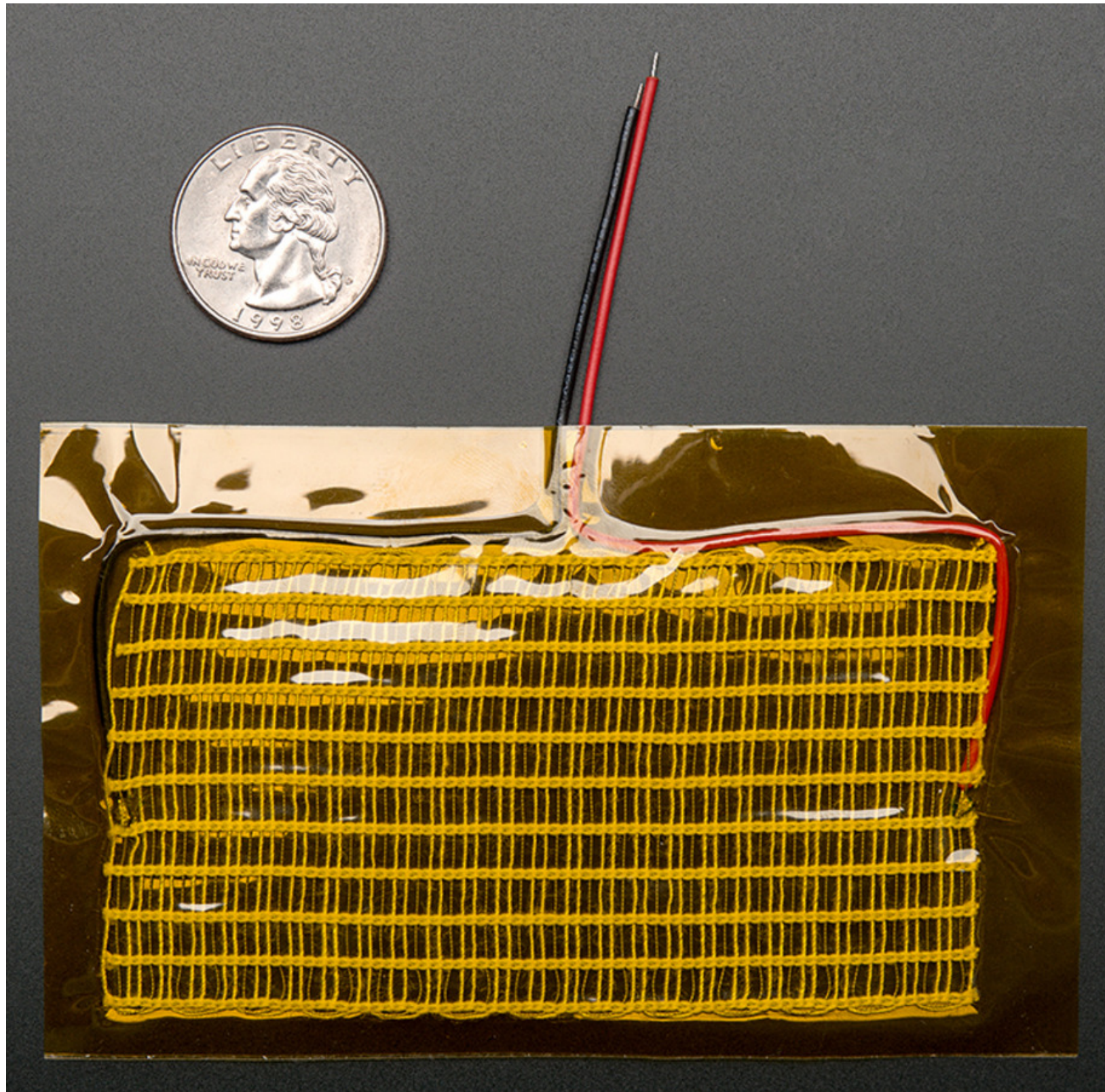


movement

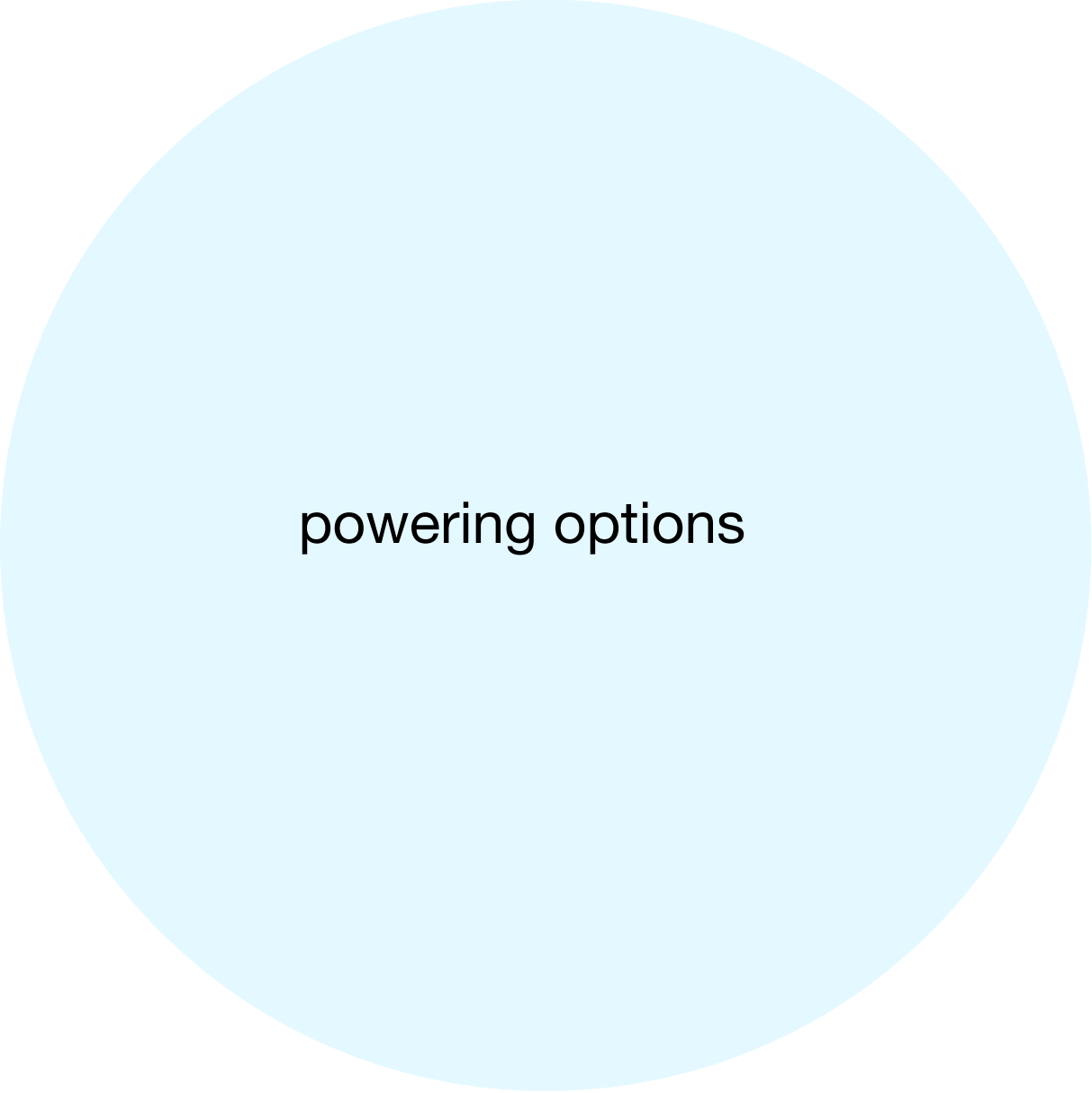




heat



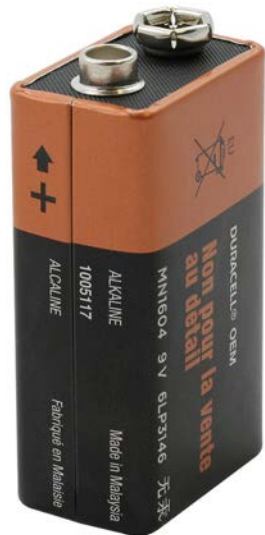




powering options

# multimeters

basic uses



## testing VOLTAGE

set dial to AC or DC voltage  
choose the smallest range  
that is larger than the  
number of voltage you think  
is present.

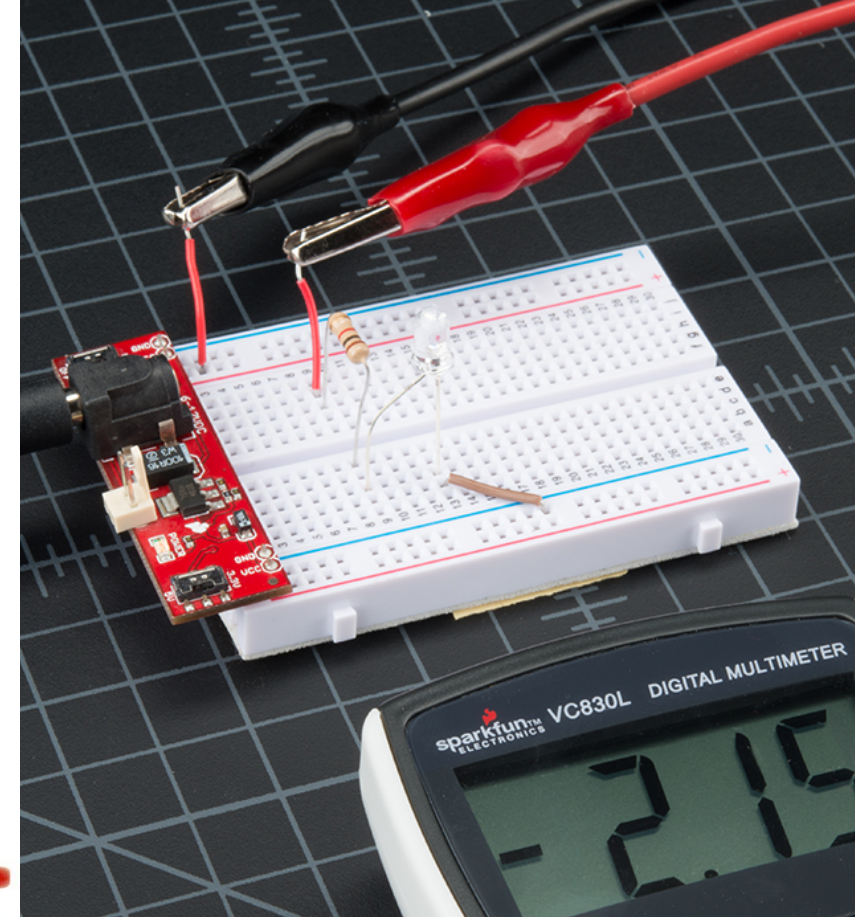
ex: testing a 9V battery, set  
to 20V



## testing CONTINUITY

to check if two points are  
electrically connected to one  
another.

turn dial to continuity setting,  
put one lead on  
each node and there will  
be a loud beep if it's  
conductive.





## power sources - USB port on micro controller



### USB charging stations

You can use a multi-slotted USB charging hub or a single USB cell charger that plugs into an outlet.

You will need a USB 2.0 to \_\_\_\_\_ depending on the input of the micro controller you are using.



### \*Computer as power source

Boards can also be powered through the USB port on your computer.



### Portable cellphone charger pack

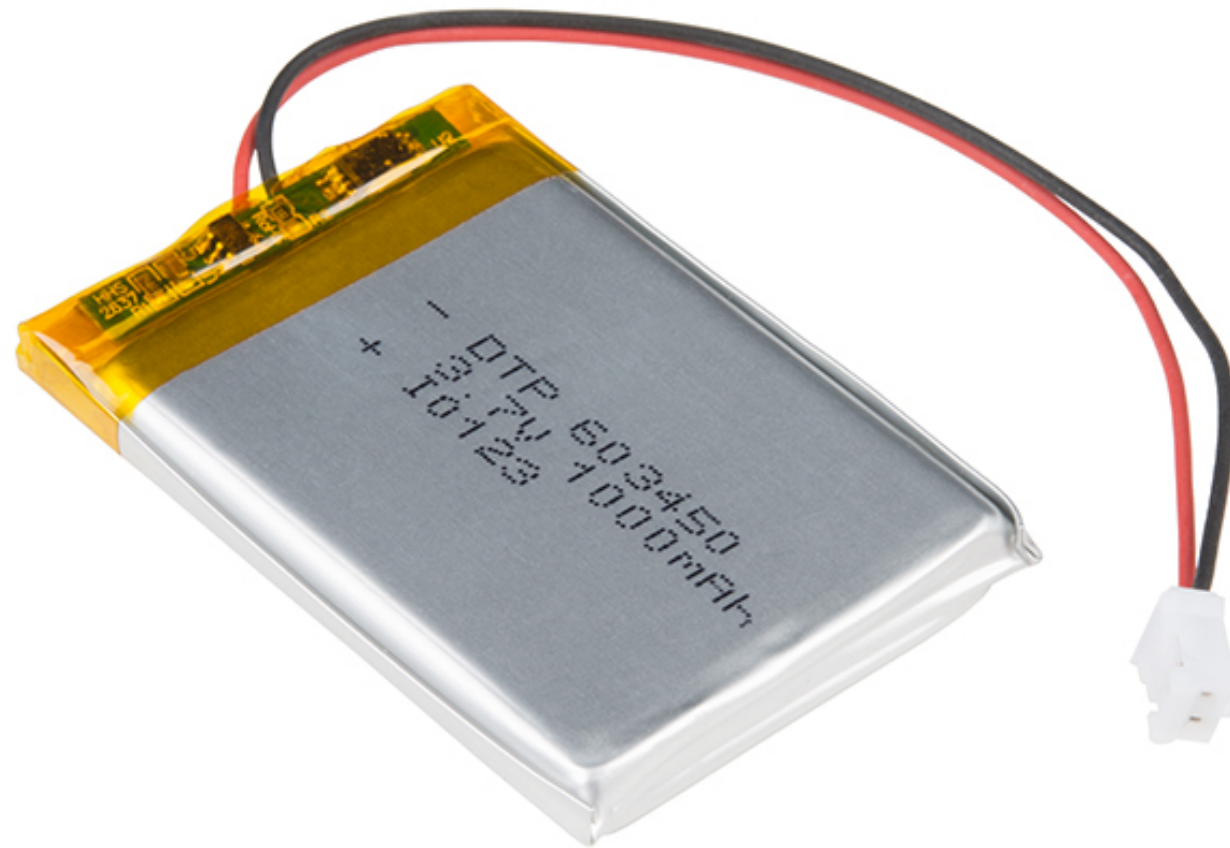
They can power a micro controller without a wall plug in, however don't last as long.



### Universal Qi Wireless Receiver Module

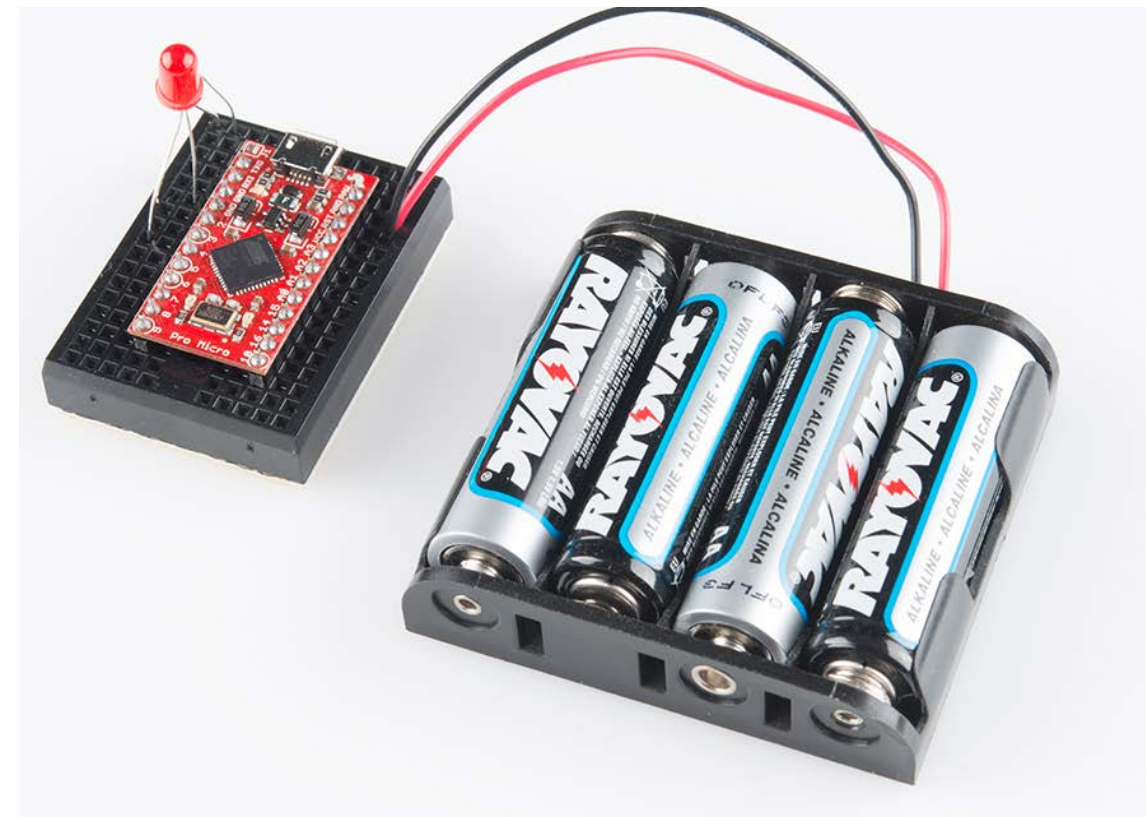
It's possible to recharge your Arduino wirelessly

## power sources - battery packs



### 3.7V LiPo Rechargeable Battery

If you don't want your board to be cable connected, you can use a rechargeable LiPo battery for stand alone projects.



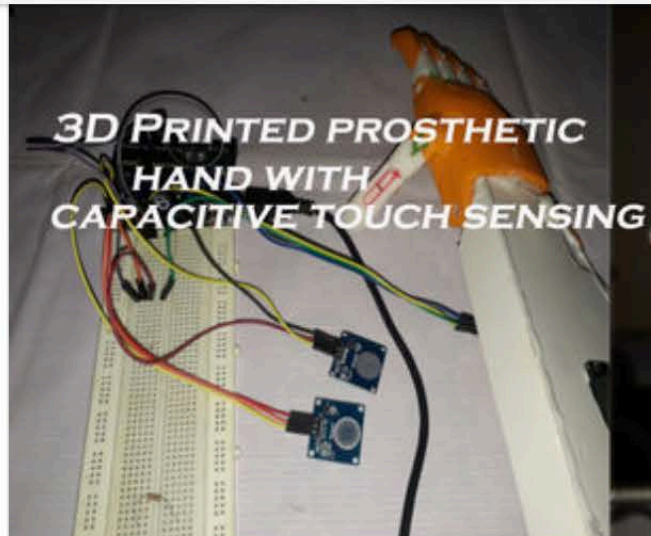
### AA Battery Pack

These range in voltage output, so make sure to know how many volts your board needs to function. Usually this ranges from 3-5V.



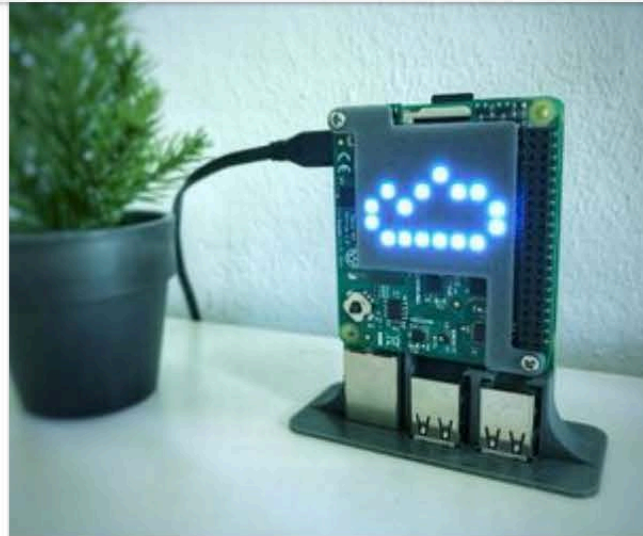


self-teaching platforms on the Internet



**3D Printed Prosthetic Hand With Cap...**  
by AmalMathew in Arduino

★ 12 688



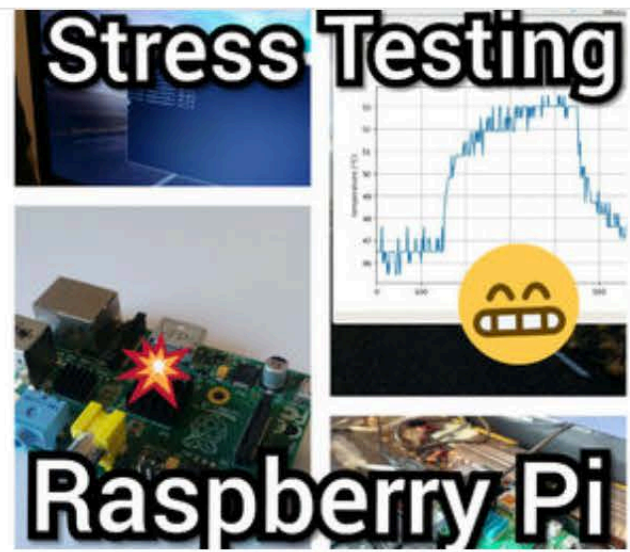
**RPi Weather Station and Digital Clock**  
by Anders644PI in Raspberry Pi

★ 25 1.4K



**Arduino Pocket Game Console + A-Maz...**  
by alojz in Arduino

★ 🏆 Runner Up 57 3.1K



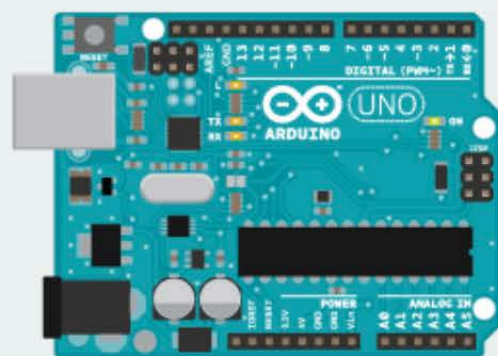




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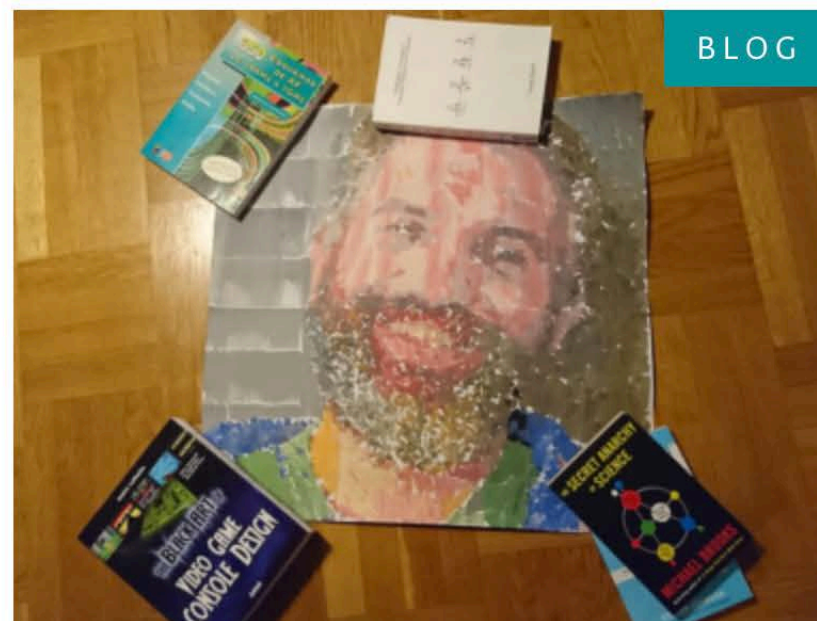
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MAKING, MANUFACTURING, DRIVING THE 4.0 REVOLUTION

IN PARTNERSHIP WITH DISTRELEC

ARDUINO



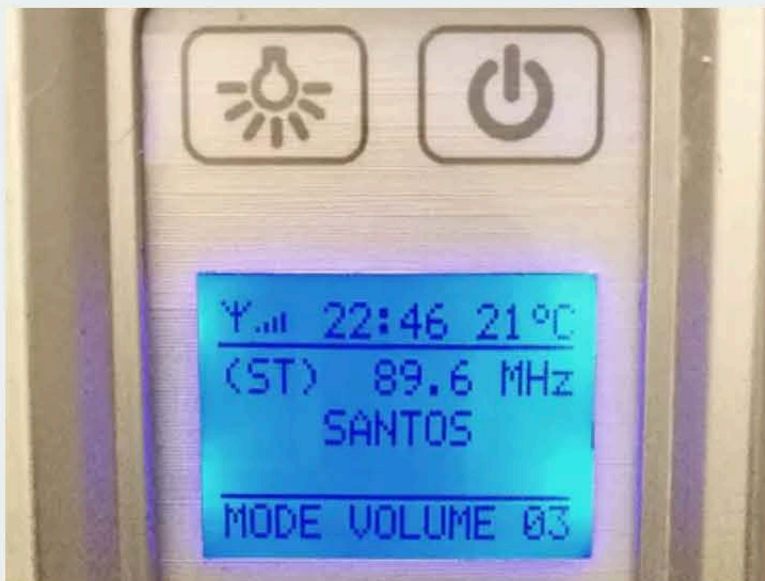
All products ▾

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Trending ▾

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Any type ▾



Arduino-Based Shower Cabin FM Radio



BBC Micro Online



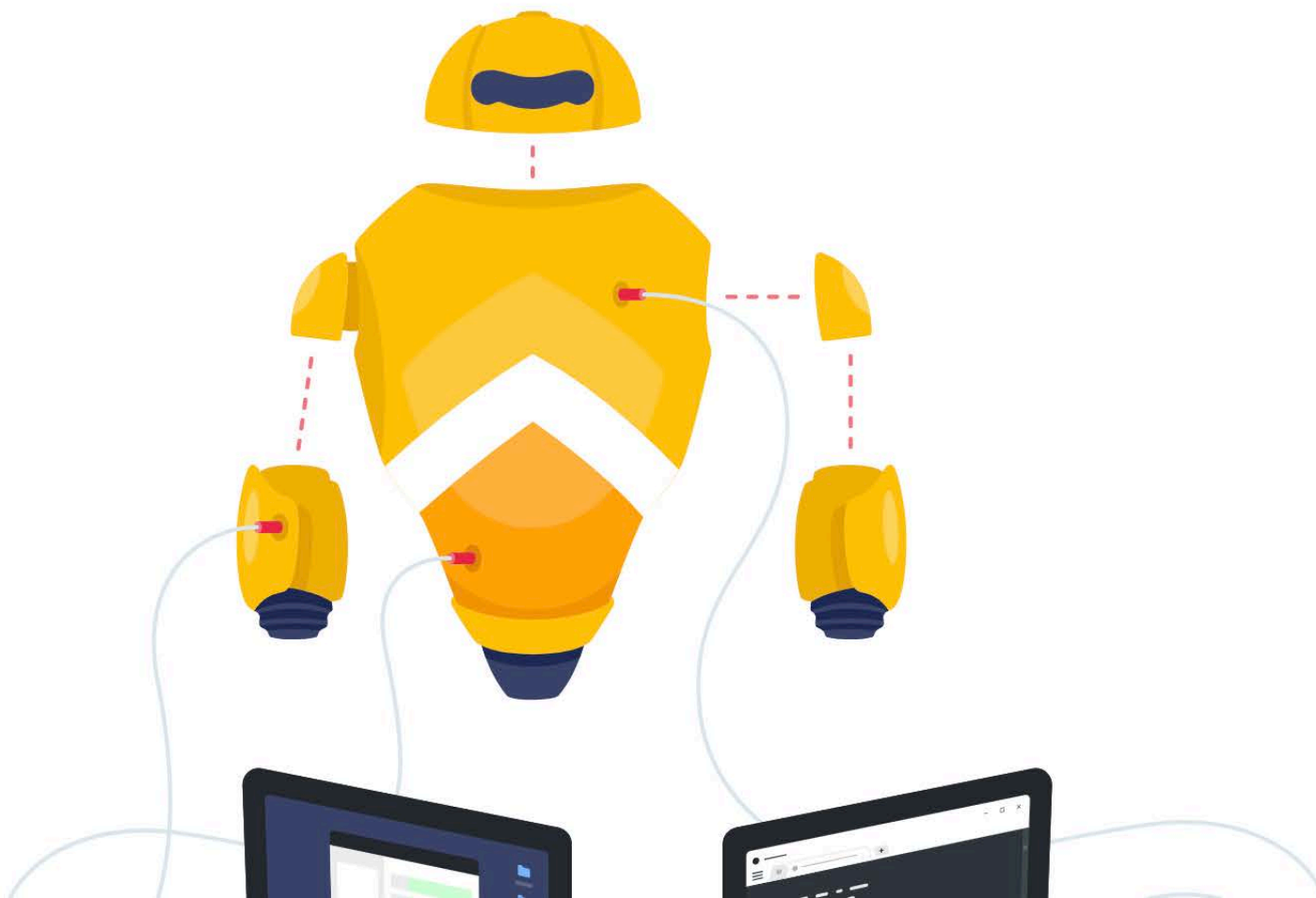
Arduino MIDI Arpeggiator



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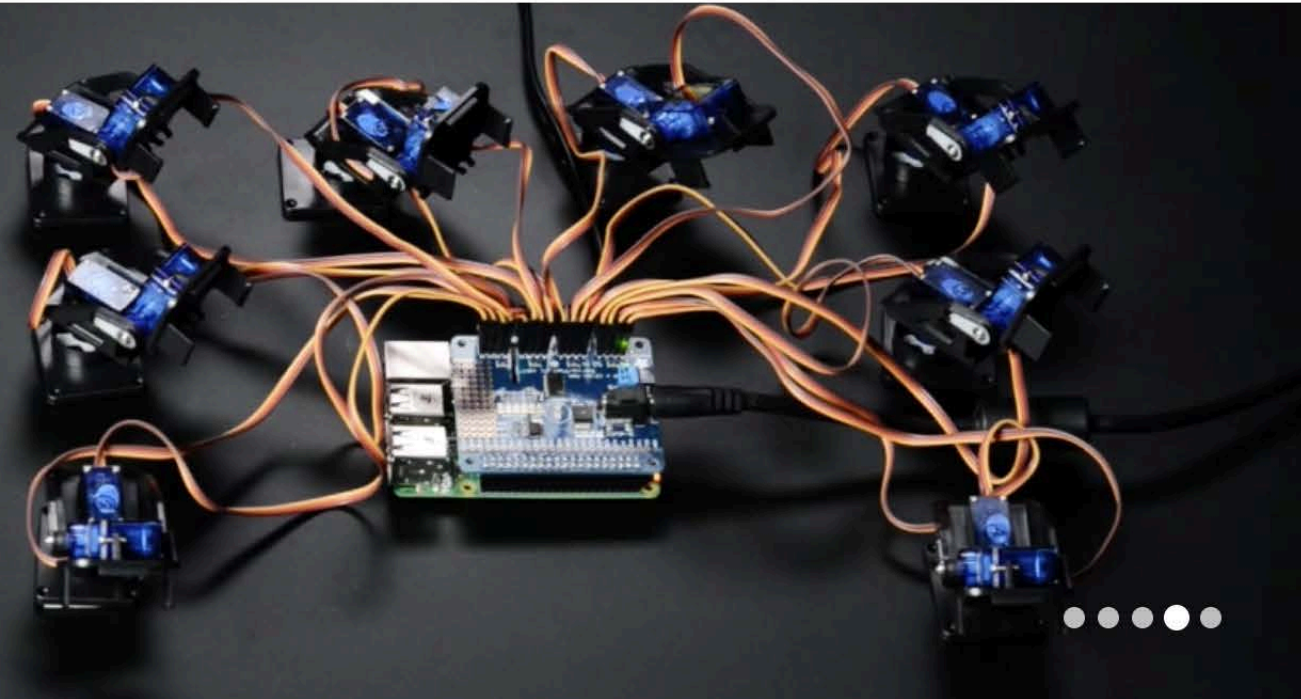
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## ADAFRUIT 16-CHANNEL PWM SERVO HAT

FOR RASPBERRY PI



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Fritzing is an **open-source hardware initiative** that makes electronics accessible as a creative material for anyone. We offer a software tool, a community website and services in the spirit of **Processing** and **Arduino**, fostering a creative ecosystem that allows users to **document** their prototypes, **share** them with others, **teach** electronics in a classroom, and layout and **manufacture** professional pcbs.



## Download and Start

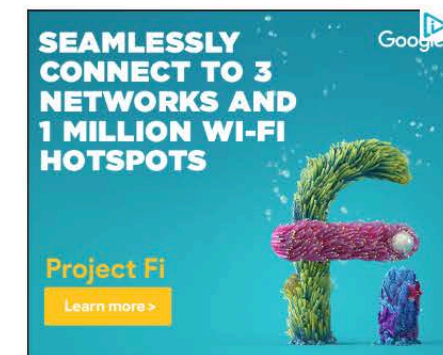
Download our **latest version 0.9.3b** released on June 2, 2016 and start right away.

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## Blog

**Fritzing Fab now powered by AISLER**  
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**New fritzing release 0.9.3b!**  
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**New Book: "Fritzing for Inventors"**  
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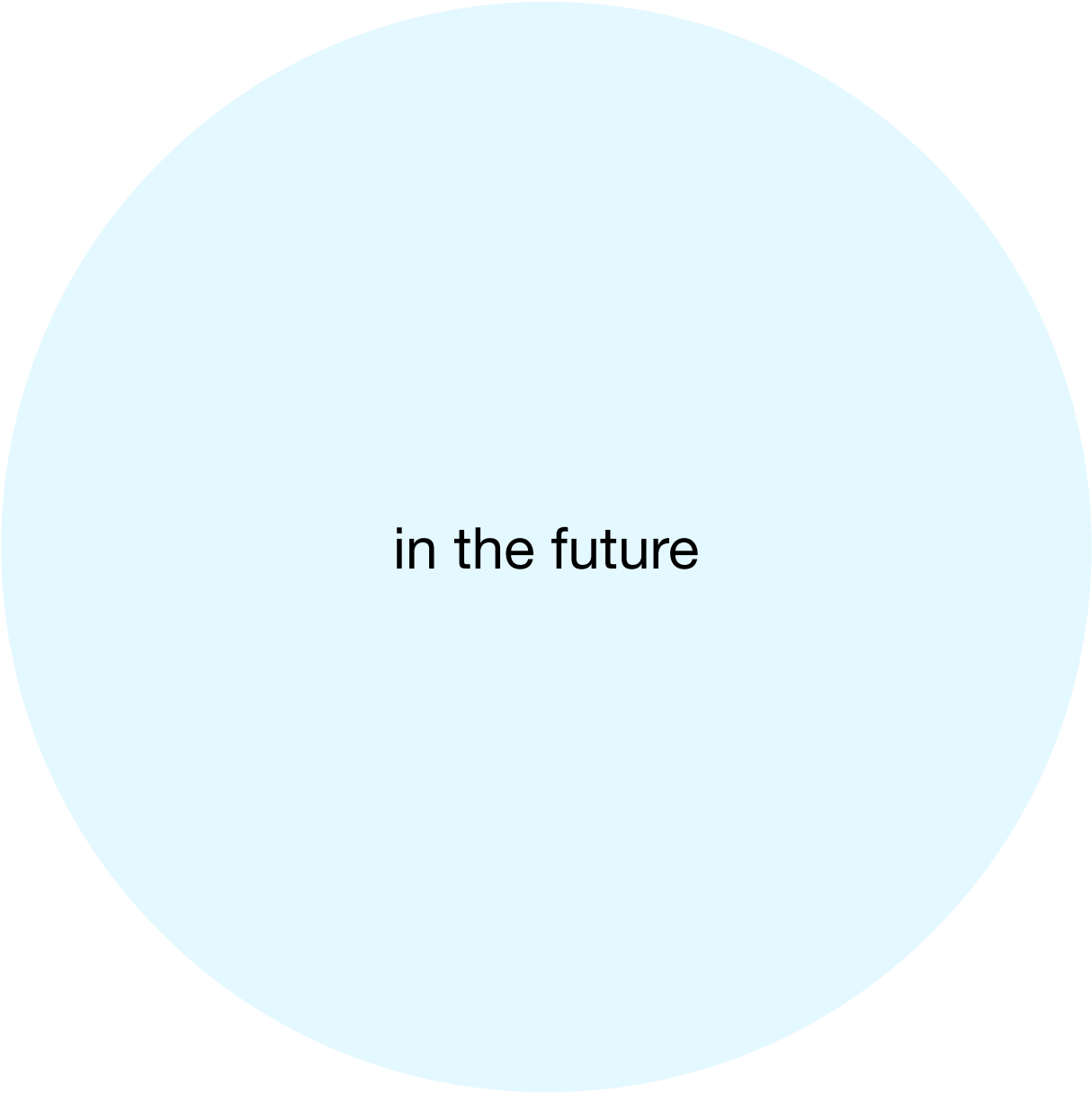
## Projects

**Jaime Figueroa ( Colegio Nuevo Mundo - BETA - Jaime Huaranca)**  
JaimeFigueroa

**[NodeMCU] Red Green SOS**  
gbanis

**Servo control with Arduino**  
rirkam1





in the future



Kimberly Lyle  
*Floating Vowels*  
Arizona State University  
2017-18





Julianne Swartz  
*We Complete*  
Cambridge Common Park, Cambridge, MA  
2017













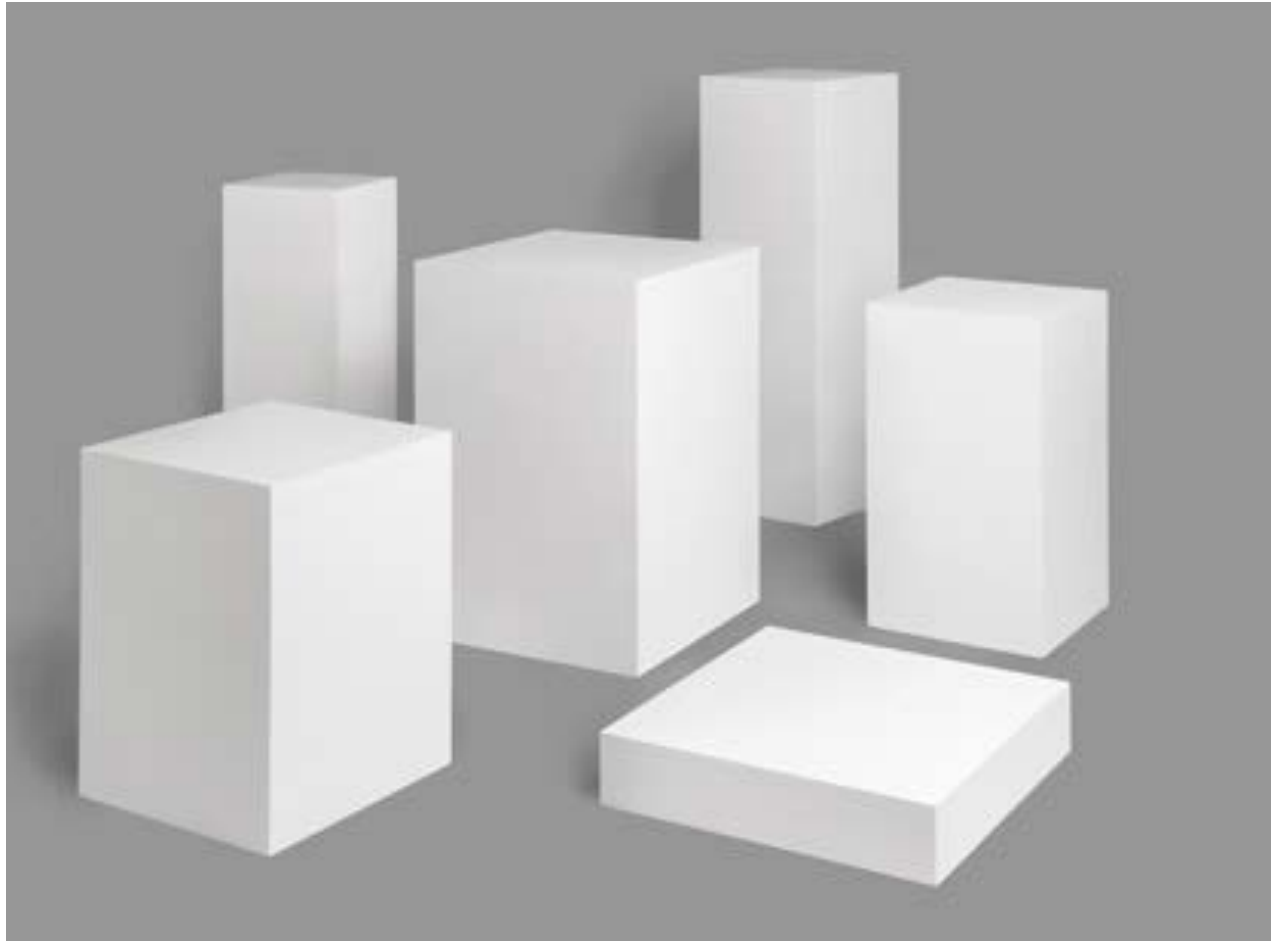


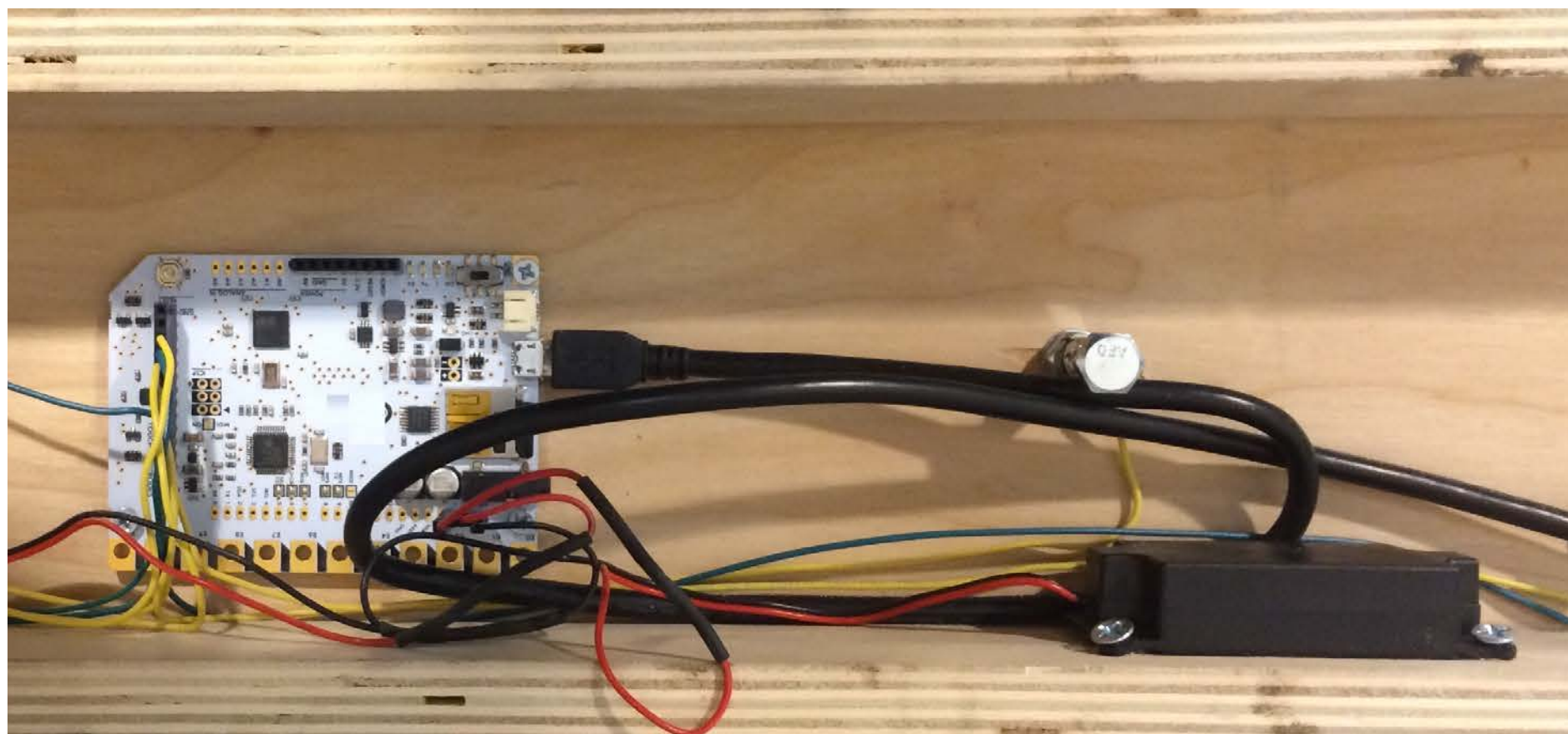
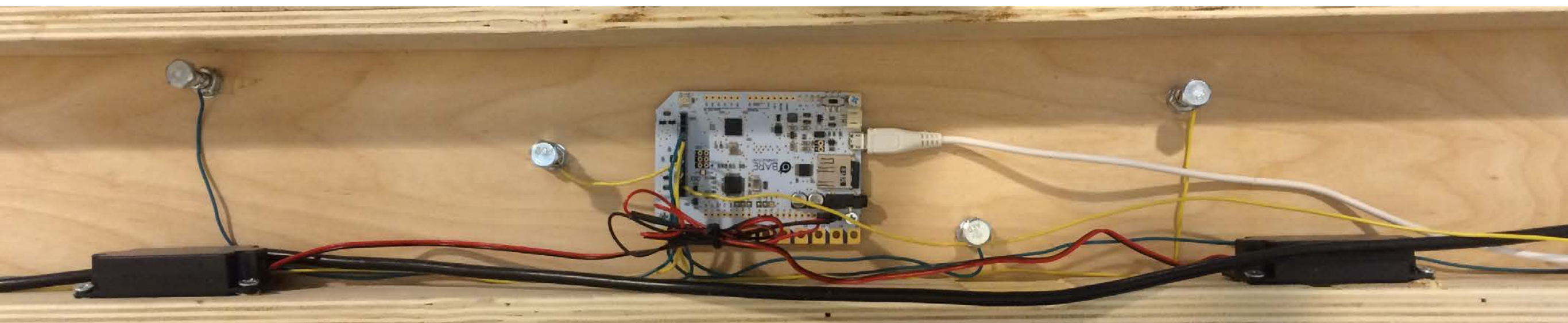
A large, solid light blue circle is centered on a white background. Inside the circle, the text "how to integrate system into cast object" is written in a black, sans-serif font.

how to integrate system into cast object





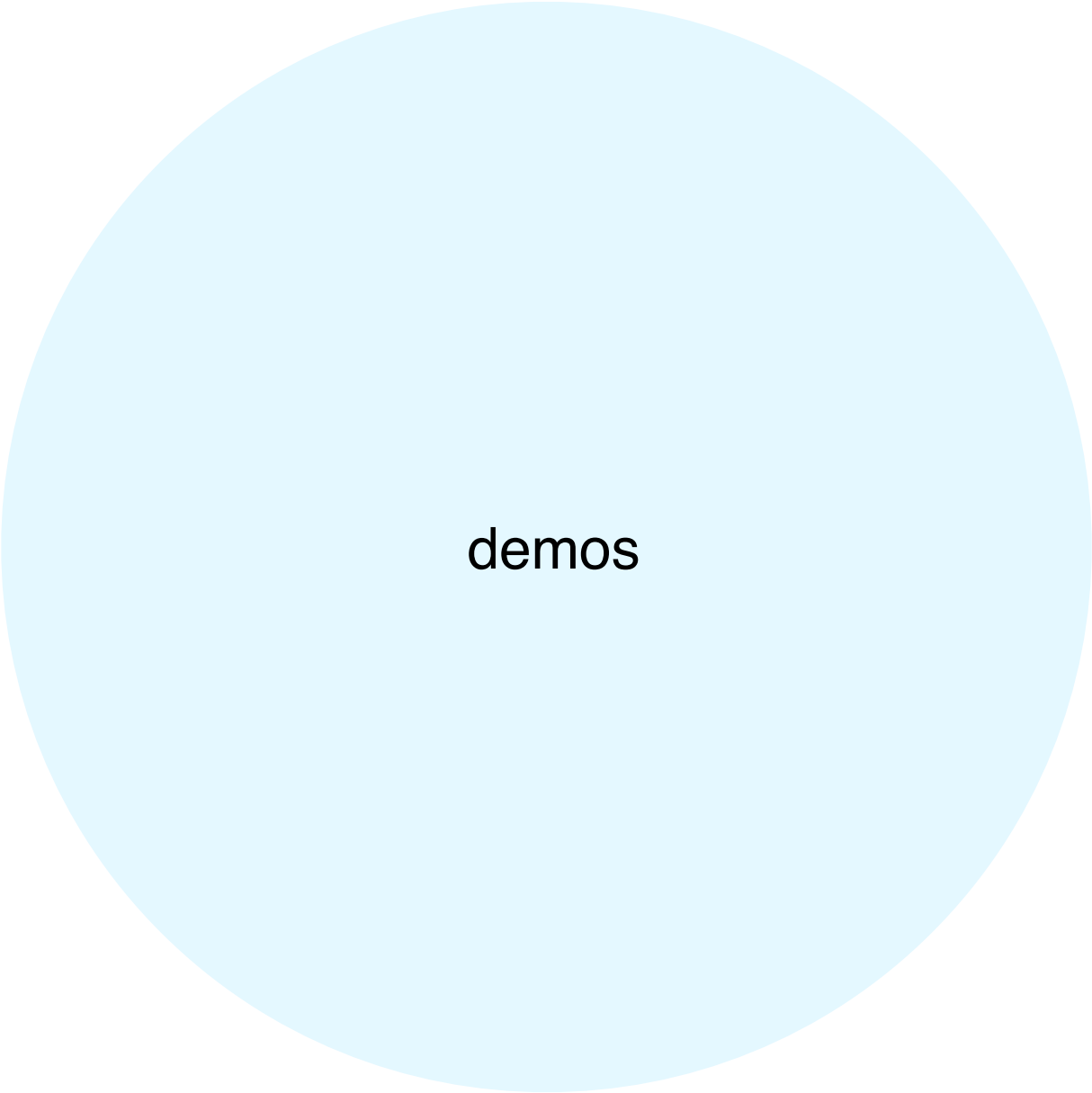








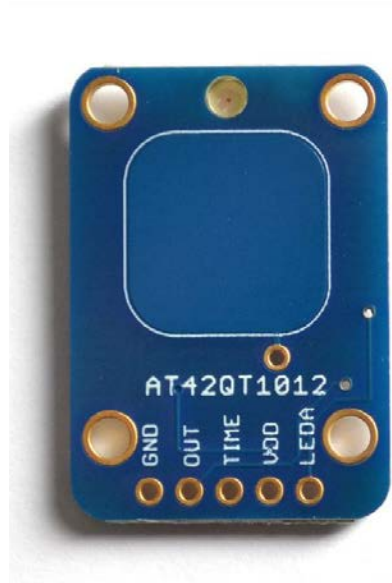
Miki Iwasaki  
*Signalscape*  
San Diego  
International Airport  
2011



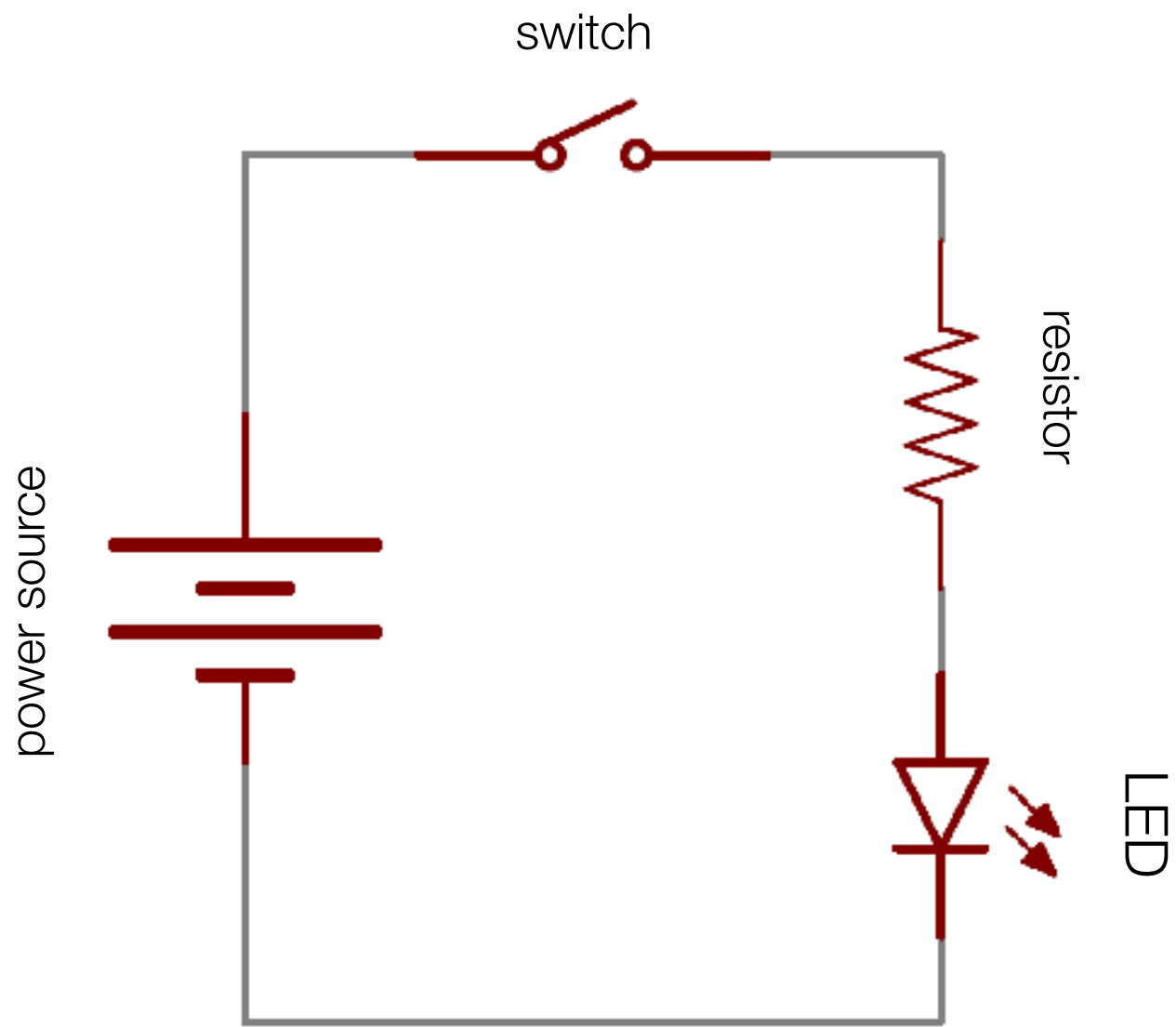
demos



## demo 1: stand alone toggle board to trigger light

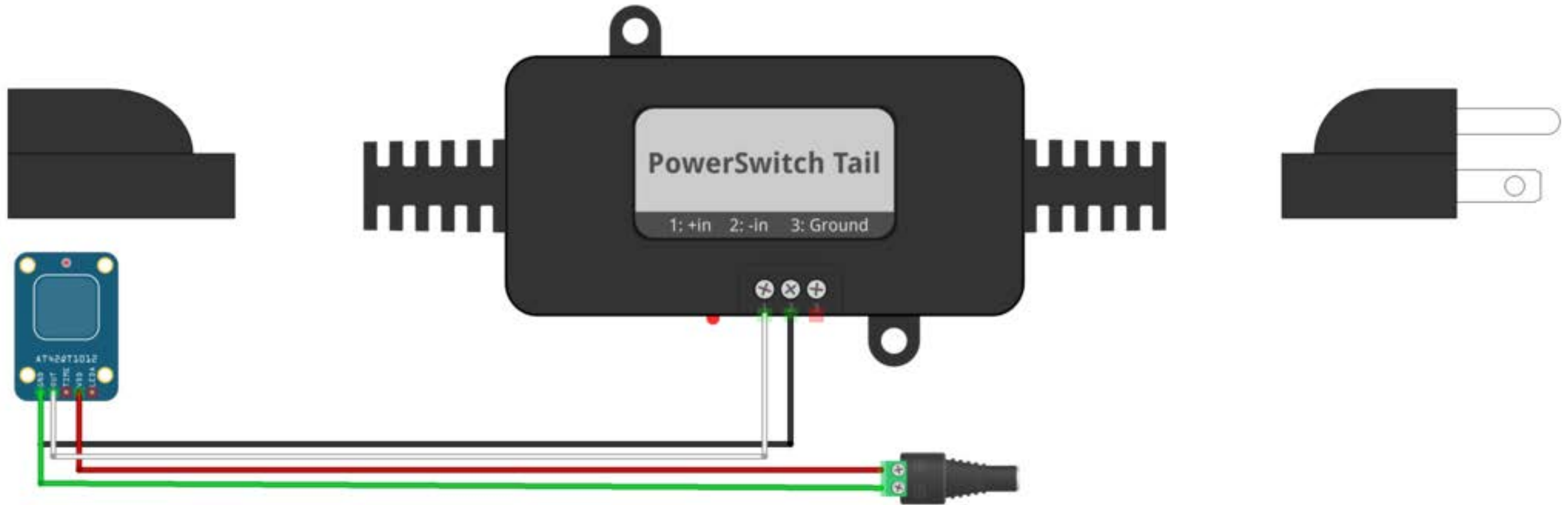


basics of a switch



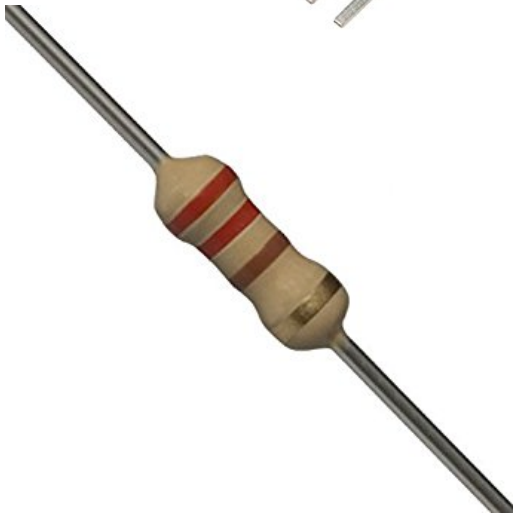
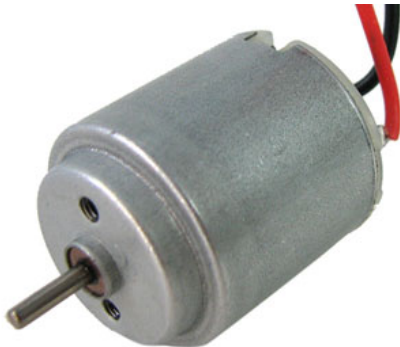
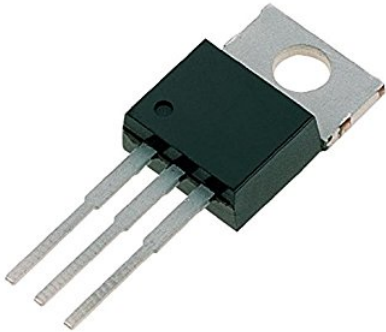
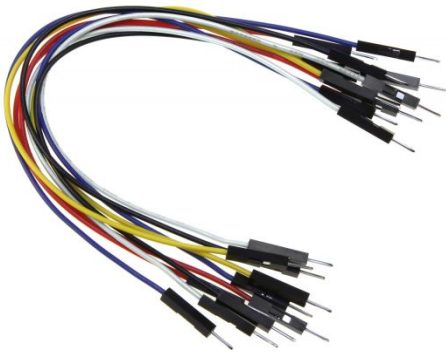
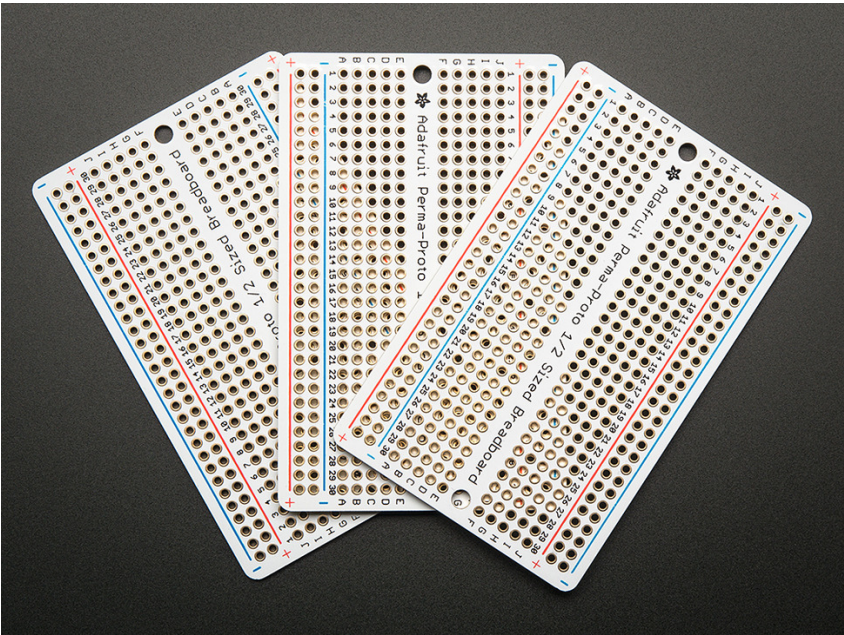
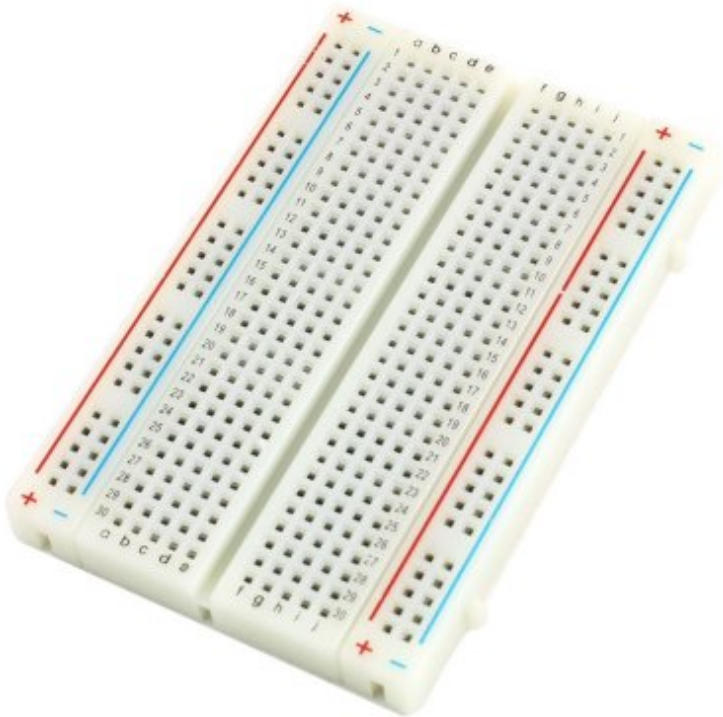


**demo 1:**  
stand alone touch toggle board to trigger a switch



fritzing

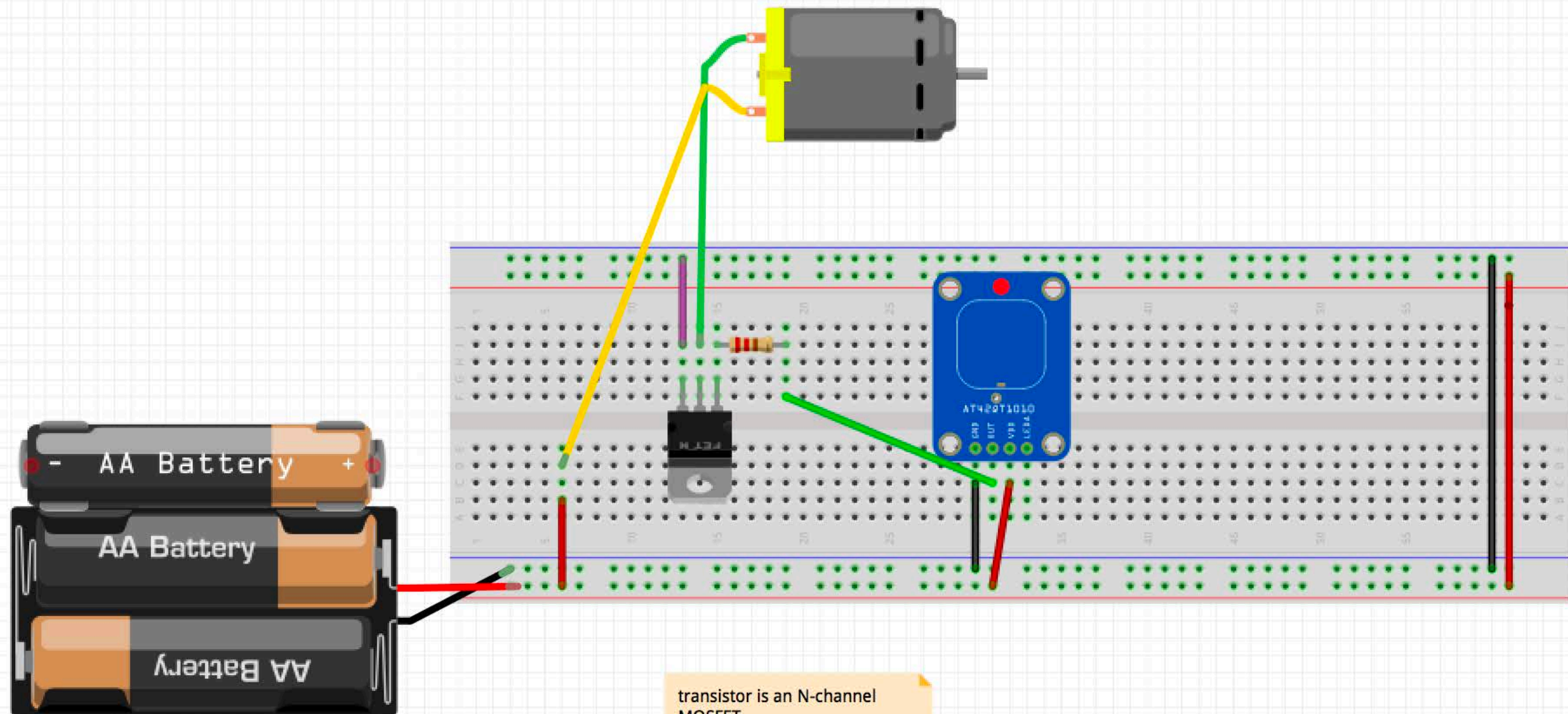
demo 2: stand alone momentary board  
to trigger DC motor





## demo 2:

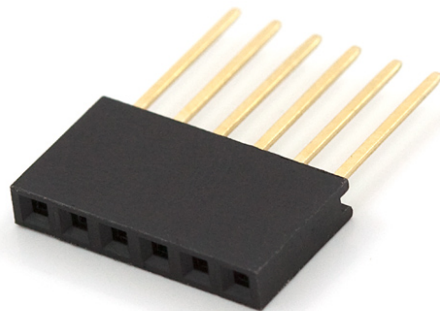
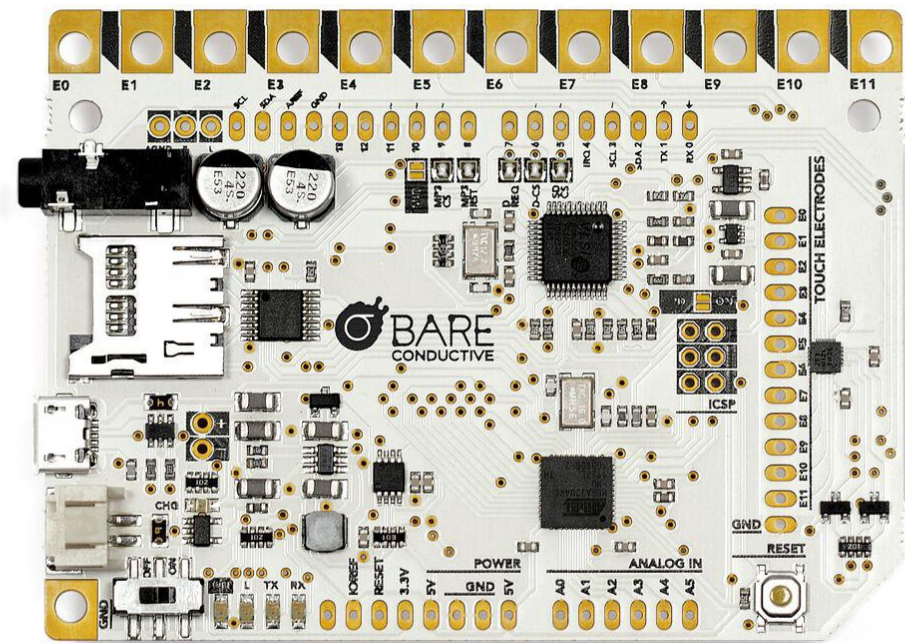
stand alone momentary board to  
trigger DC motor



transistor is an N-channel  
MOSFET

resistor is 10K ohms

demo 4: bare conductive touch board  
to trigger up to 12 sounds





### demo 3:

bare conductive touch board to trigger audio

